

Compressed Air

Magazine



AUGUST 1959

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TOY STEAMERS
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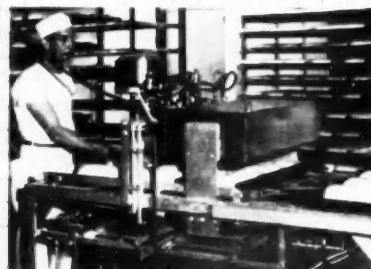
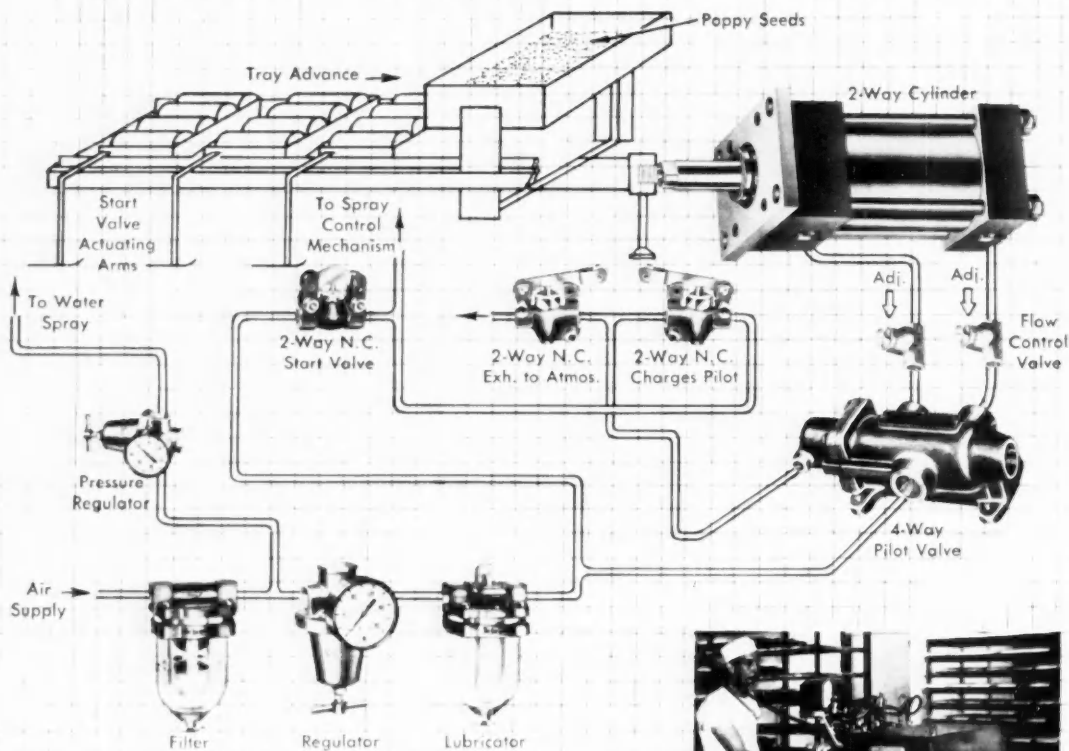
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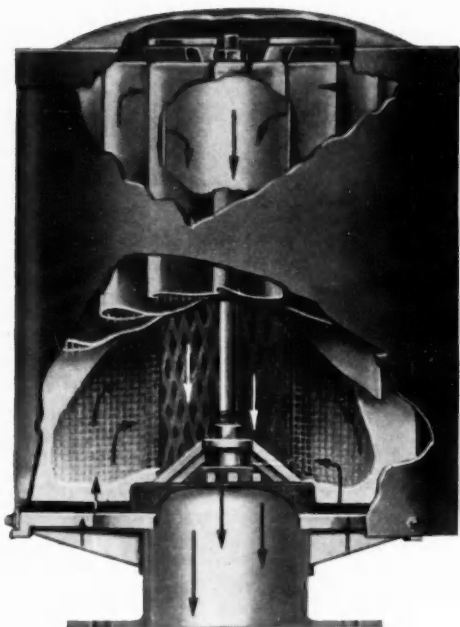
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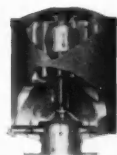
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Write for Bulletin 100 which contains complete engineering data and illustrated material on Staynew Intake Filters. Dollinger Corporation, Dept. 7, Centre Park, Rochester 3, N.Y.



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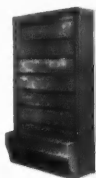
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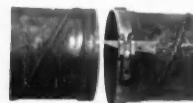
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Write for Bulletin No. 59.

How NAYLOR Wedgelock Couplings Speed Connections



1 Drive wedge into two parallel lugs to open coupling.



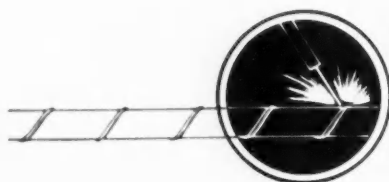
2 Slip coupling over pipe and put next section in place.



3 Drive out opening wedge so coupling snaps into place on grooved ends of pipe.



4 Drive wedge home into the three lugs on coupling. A hammer is the only tool needed.



NAYLOR PIPE *Company*

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PHOTO, CANADIAN NATIONAL RAILWAYS

ON THE COVER

THIS month, COMPRESSED AIR MAGAZINE takes time out to wish all of its readers a pleasant and safe vacation season. Our cover picture makes us think of all the cool, shady lakes and streams available throughout the vast network of national parks and forests on the North American continent. The photograph is of mile-high Maligne Lake in Jasper National Park in the scenic Canadian Rockies.

FEATURE ARTICLES

Page 6 Fiber Glass Afloat—G. R. Smith

Sleek and sturdy, the four models in Atlantic Marine Industries' Newport boat line demonstrate the advantages of fiber glass construction. Their fabrication is explained in this story as the combination of manufacturing skill, compressed air power and new building materials.

9 From Bicycles to Missiles—S. M. Parkhill

Through the past 58 years, Thompson Ramo Wooldridge Inc. has grown in annual sales from \$250 to a volume currently ranked one-hundred twenty-fourth among the 500 largest industrial corporations in the United States. This is the history of that remarkable development.

12 The Story of Asbestos, Part II—Peter Sleight

Cassiar Asbestos Corporation's facilities in British Columbia form the subject for this final part of a series about the "cotton stone." The story takes the reader from the mining operations, through the milling and grading steps, to the shipping of this unique material.

18 Toy Steamers of a Day Gone-by—Henry C. Suter

Midget engines fill the home of Greville Bathe, a retired mechanical engineer with a hobby of building and collecting scale-model steamers of ages past.

22 Molecular Still

Simple in design and easy to operate, this Bureau of Standards' device makes possible rapid and efficient separation of high-boiling-point materials.

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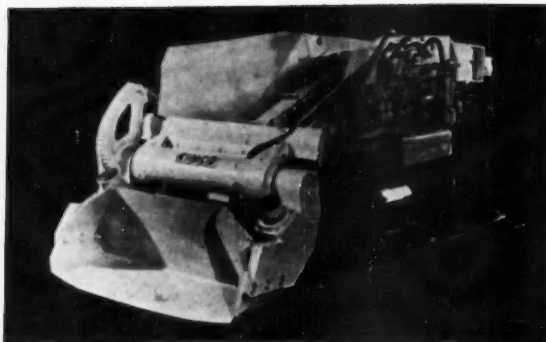
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Frank Garrett is mine superintendent at this operation, which also uses an Eimco Air Tugger Hoist to pull the drill jumbo to one side when it is hoisted out of the shaft and an Eimco 42" Folding Scraper to load their skip pocket.

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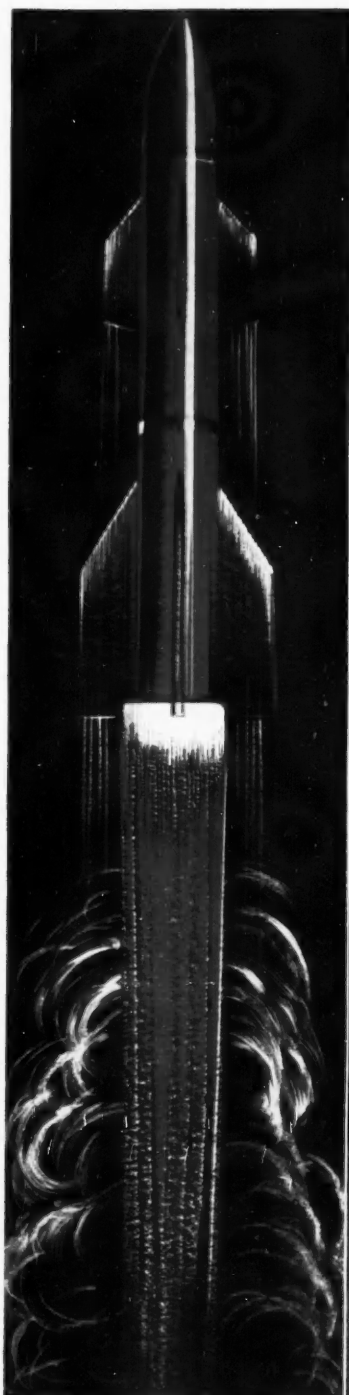
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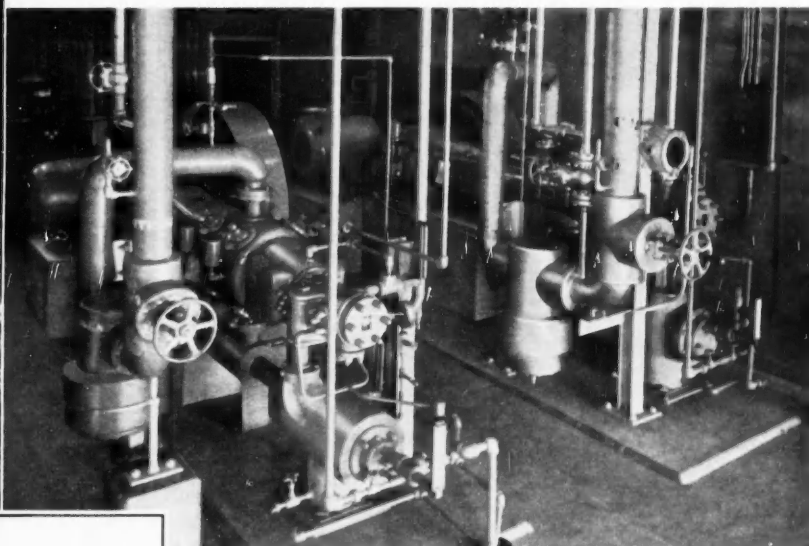
Recently the U.S. Navy and the Callery Chemical Company jointly dedicated their new HiCal plant in Muskogee, Oklahoma—America's first large-scale facility for the production of boron-based high-energy fuel. This new exotic fuel will power missiles, super aircraft, and possibly even man's first steps into space.

A large assortment of Ingersoll-Rand process compressors and pumps at Muskogee are working around the clock to maintain a continuous production schedule. One of the major processing units is the gas plant which produces hydrogen, carbon dioxide and nitrogen. Here a new-design Ingersoll-Rand ESH two-stage compressor handles carbon dioxide at

305 psig discharge, and another two-stage I-R unit compresses nitrogen to 500 psig. Two three-stage TVH's compress the hydrogen to 310 psig.

The Muskogee plant also includes 47 Ingersoll-Rand centrifugal pumps of various types and ratings.

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Ingersoll-Rand two-stage compressors at the new HiCal plant. At left, an ES nitrogen compressor; at right, compressing carbon dioxide, is an ESH unit of revolutionary new design.

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COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

TWICE daily at the "Ski Follies" on the Absecon Boulevard near Atlantic City, N. J., a 15-foot runabout is launched swiftly into the 26 acres of salt water and steers toward a water-ski ramp. As its outboard prop bites in, the trim craft picks up speed to about 22 mph. The fiber glass hull meets the ramp and becomes airborne off the tip. The boat arcs 15 feet in space before falling back to the surface and speeding gracefully away.

The craft chosen for this spectacular but demanding task is a stock model of one of four built by Atlantic Marine Industries, Pemberton, N. J. The young company's quality products are examples of the new fiber glass look—and performance—in boating; further, the process of fabricating the boats is an

outstanding example of how use of compressed air and gases is combined with today's new materials to create improved products.

Atlantic Marine Industries was formed 2 years ago by a company in Pemberton that manufactures custom-built houses. This concern wished to diversify its efforts, and because housing is one of the necessities of life, the company believed the recreation field would provide the desired dissimilarity. Among the firm's executives were several who had experience in the boat building industry, so this specific field was chosen. Their first problem was the research and development of the boats they would later manufacture and market.

After about a year's investigation into boats and the use of fiber glass for building them, Atlantic Marine's ideas were presented to the New York naval architecture firm of Kean & Ketcham. In a short time a 15-foot runabout emerged from the drawing boards and a new boat was born, first in the Newport line. After extensive testing, the craft went

into production and was introduced at the national boat show in New York City early in 1958. Simultaneously, Atlantic Marine began recruiting a sales and dealer force to handle the new boat and its sister models then being designed.

About five-hundred 15-footers were built and sold in 1958, during which three new additions were made in the line. These included a deluxe 17-footer (similar to the original boat but with the added length) and utility versions of both the 15- and 17-foot models. The utility boats are essentially the same as the deluxe ones, but lack the plush seats and the handy mid-deck. All four of the Newport boats (it is expected that 1500 to 2000 of them will be manufactured and sold in 1959) are built in the efficient workrooms of the company.

DELUXE RUNABOUT

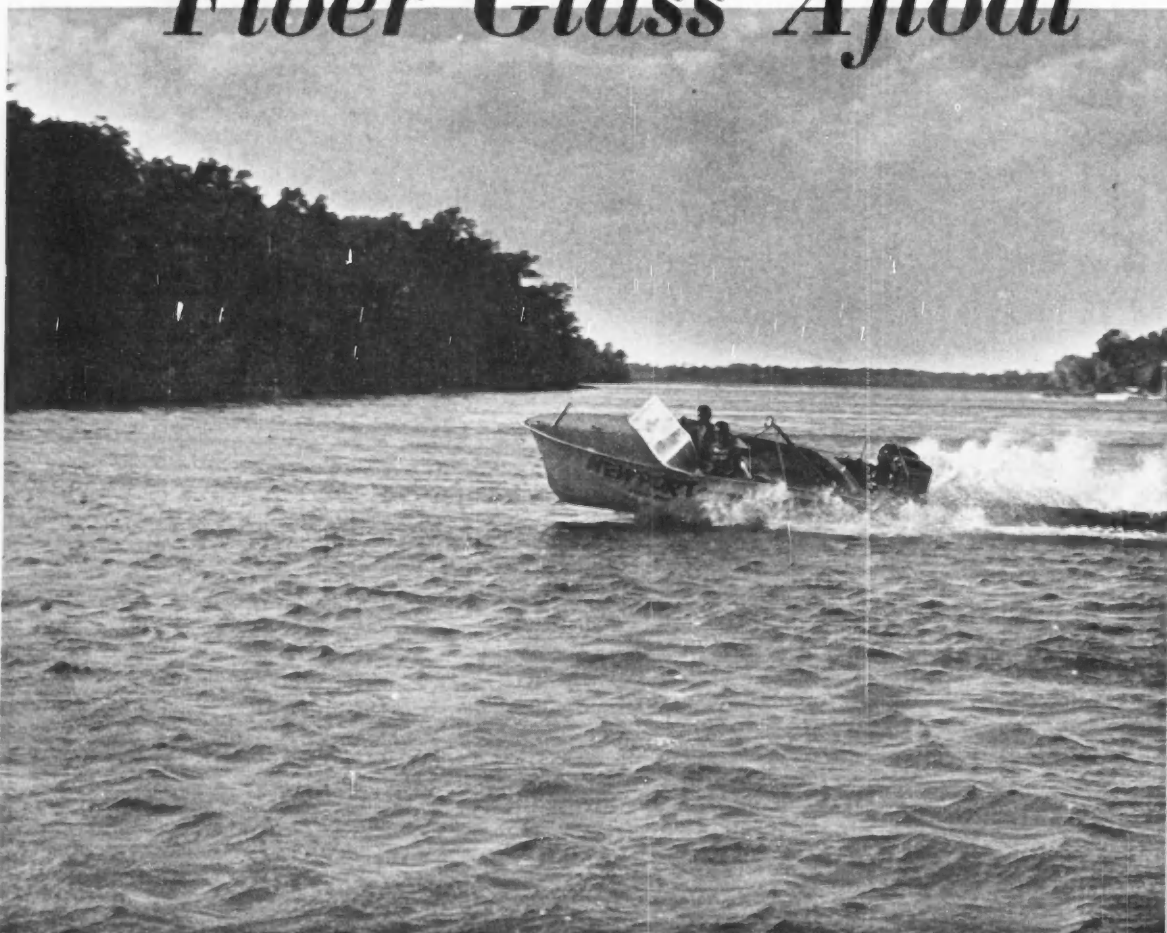
A 17-foot Newport Deluxe Runabout skims the water powered by two 60-hp outboard motors. The craft is specially rigged for towing water skiers.

Boat's Construction

Basically, a Newport boat consists of two major laminated fiber glass sections—a hull and a deck. These two components are made separately and each

G. R. SMITH

Fiber Glass Afloat



First, the mold is cleaned and waxed and an outer coat of pigmented polyester resin is sprayed on through air-powered catalyst guns. Next, as these workers are doing, a layer of fiber glass cloth is neatly placed over the outer coat. Lay up operations and "foaming" are completed in this special, enclosed room.



After the fiber glass cloth come laminations of mat and heavy roving. These men are working out the overspray of polyester resin that will secure the roving to another layer of fiber glass cloth to come.



A gray binder is sprayed to the hull as it approaches its final lamination. In the bottom of the boat a sheet of mat has been laid up on top of a thick foam layer. The unique foam section is a flotation unit and a stiff structural member.



Decks of Newport boats are formed separately as one piece and later fitted to hulls. Here the vertical sections of the deck, upturned to provide easier accessibility, are coated with pigmented resin. Eventually they will form compartments in the front of a boat.



FINISHED BOAT

After hull and deck are fitted together, and hardware and seats installed, the boat is cleaned. It then can either be shipped or stored in the open. This boat is receiving a thorough treatment with an auto cleaner compound before being sent to a customer.

is a single solid piece. Fiber glass in this application has several advantages over wood; undoubtedly the most important is simplified maintenance. In most areas, a wood hull usually demands major attention at least twice a year as the boat is prepared for the summer's use and when it is taken from the water in the fall. A fiber glass one needs almost no major maintenance. It can be easily cleaned and painted and can be removed or returned to the water at will. Another advantage of fiber glass is its light weight compared with wood; still another is its fire resistance.

In building a Newport hull, a mold of the desired shape (fashioned also in Atlantic Marine's own shops) is first lined alternately with close-woven fiber glass cloth and mat, and with heavy fiber glass woven roving which has a much coarser weave. Layer upon layer are "laid up" inside the mold until a sufficient thickness has accumulated to provide the size and strength needed. Using an air-powered atomizer spray gun, each layer is sprayed with a polyester resin binder that fuses the fiber glass cloths into a tough solid shell. The next step, called "foaming," is one of the most interesting procedures in the construction of a boat. This process gives the craft another advantage over the once traditional wooden construction: a long 2½-inch-thick layer of buoyant polyurethane foam that makes sinking of the boats nearly impossible. When laid down into the bottom of the boat, from side to side and transom to

bow, this lightweight but strong member creates a nonsinkable flotation unit. It also is a sound deadener and a hull stiffener. This is what helps make the boat safe for such a strenuous stunt as hurling off a water-ski ramp. Handling of the fiber glass and the other materials and chemicals which go into the boat is no simple task. Curious as it may first seem, Atlantic Marine employs a chemical engineer full-time to work out the process problems that appear.

Deck construction also proceeds by lay ups applied to molds. The decks are fashioned upside down so that the vertical members of the dash and compartments are more accessible to workmen. One of the fine over-all characteristics of the Newport boat is the strength of its deck as well as its hull. The deck won't bend even if stepped on. Under it are three 8-inch-wide stringers, 1½ inches thick, molded-in to provide strength. Another member supports the boat's dashboard.

Because spraying operations inevitably cause materials to become suspended in the atmosphere, all power tools used in both the initial construction and the finishing of the boats are air powered. Even the lighting in the lay up and foaming room is specially designed and enclosed so that there will be no danger from sparking.

After the lay up operations are complete, the rough edges of hulls and decks are trimmed and sanded with air tools so that superfluous fiber glass is removed and so that a smooth hard finish is

present. After the two components are bonded together with fiber glass mat and resin, the hardware fittings, windshields, seat cushions and a long hull-protective strip of neoprene are installed. At this point the boats are either shipped to a dealer or customer, or stored until sold. Since weather has almost no effect on fiber glass, the boats can safely be kept outside to save space. When needed, they are merely brought back into the finishing room and given a thorough cleaning with an automobile cleaner compound. They are then polished and shipped.

Boat's Performance

When given a critical performance test by a well-known boating magazine, the Newport boat emerged with an above average rating, although the line had been introduced only a few months earlier. The first model, the 15-foot deluxe runabout, was the one tested. The publication considered the Newport as a "top drawer" product, then went ahead to evaluate six characteristics: safety, comfort, adaptability, durability, styling and speed.

Safety was listed as being above average because of the stability of the boat; it handled outboard motors up to 60 hp admirably, and the evaluator reported that it would take extreme carelessness even to swamp or capsize the craft with this large motor. Another safety feature admired was the air flotation unit. (At that time the Newport used a molded corrugated float and stiffening member but since has adapted the foam type.) The fire retardant quality of the fiber glass was also praised.

Comfort was said to be above average also. This was because of the well-cushioned and well-shaped seats and the comfortably rounded cockpit coaming. Also mentioned was the dryness of the rear cockpit—even in choppy water or sharp turns. A rail molded into the hull just above the water line helps keep out spray.

Adaptability received an excellent rating because of the Newport's well planned cockpits, ample storage space for fishing and water-ski equipment and other such gear, its molded-in battery and fuel-tank container, and the use of control lines neatly concealed under the inner cockpit molding. Durability also was marked as excellent because of the use of heavy fiber glass lamination and the top quality resins that went into the hull, deck and cockpits.

The Newport's clean clipper-type bow and generally good lines, its easy entry into the water and graceful riding characteristics gave it an above average in styling. Finally, the Newport was given an excellent for its speed; with a 40-hp outboard motor and one person aboard, it clocked a very respectable 32 mph.

The Thompson Ramo Wooldridge Inc. Story

Part 1

FROM BICYCLES TO MISSILES

A Portrait of Diversification

S. M. PARKHILL

NOTHING must have seemed more remote than the exploration of outer space to David J. Kurtz, first president of Cleveland Cap Screw Company, the predecessor of today's \$340.5 million Thompson Ramo Wooldridge Inc., as he looked over its first year's sales record of \$250. The little company was born in a small

red brick building in 1901 with a working capital of \$2500. Its aim—to produce, among other items, bicycle cap screws.

Growth was rapid. After the second year, sales reached \$40,000; and by the third year, a figure of \$75,000 was realized.

Within the working force of about 30

men was an electric welding foreman who was destined to significantly change the future of the company. He was 30-year-old Charles E. Thompson, a Vermonter who spent his spare time experimenting in electrical research. In 1904, he interested Alexander Winton, a pioneer in Cleveland's automotive industry, in a welded valve for automobiles. A year later, Winton acquired the Cleveland Cap Screw Company to manufacture Thompson's valves, and the youthful foreman became its brilliant general manager. With the new management came a second company name, Electric Welding Products Company.

These were exciting times in the industrial expansion of the United States, especially in the growth of the transportation industries. Henry Ford made his first 10,000 Model T cars in 1908, the same year that General Motors was founded.

"We must make our parts so good and at such a low cost that the car manufacturers won't want to make their own," said Thompson as he set the philosophy by which the company was to prosper. By 1909, sales were recorded in the \$400,000's.

The company went through another reorganization in 1925. Steel Products Company emerged, and Thompson became its hard-working, 45-year-old president, a position he held until his death 18 years later. (Frederick C. Crawford succeeded him and held the office until March 1953 when he became chairman of the board, and J. D. Wright was elected president. Following the merger in October 1958 with The Ramo-Wooldridge Corporation of Los Angeles, Calif., Wright became chairman of the



COVETED CALENDARS

The painting reproduced above was done by Charles H. Hubbell. This and similar paintings appeared on calendars published by Thompson Products. They were issued in limited editions and are now highly sought by collectors. This one shows a sea rescue; others were of the trophy races and similar important events in aviation history.

board and chief executive officer, and Dr. Dean E. Wooldridge became president.) The firm had not only become the leading manufacturer of valves for automobiles in the United States, but

in the decade and a half since its doors were opened for business, established a growth pattern and forward-thinking policy that has remained. The most recent illustration of these was the October merger.

A New Era

Shortly after Steel Products Company was formed, it was awarded a contract by the government of France to make aircraft valves. The first of these were used on the Hispano-Suiza V-8 engines that powered the famous French Spad fighters of the First World War. They were of solid-forged tungsten steel. Each had a solid head with a slightly convex top, and a partially hollow stem with an inside thread and an adjustable tappet. It was what can be considered the first precision component to come from the firm. By the end of the war, the company had established its reputation of precision work in the transportation industry, and had doubled in size.

At about the same time, an American scientist made a discovery in Delhi, India, that was to have a profound effect on the Cleveland manufacturer. He found a 1200-year-old, forged-iron column that had withstood the elements without noticeable affect. The pillar had absorbed silica on which it was standing. This made it resistant to rust and oxidation. Eventually, a silica-iron compound was developed for valve steel. With the new alloy, aircraft engines could operate steadily for 300 hours with-

out valve failure. Previously used tungsten steel valves had a 14-hour service life; and stainless steel ones, 30 hours. When the silica-iron was adopted by the Government for military aircraft, Silcrome valves set the standard. Full-throttle block tests were given the 300-hour specification. Steel Products met the test without difficulty, and though less than 30 years old, the corporation laid the foundations for its steady aircraft business.

Thompson Products, Inc., was adopted as the company name in 1926 to honor its president. Through his efforts, the firm had expanded rapidly. In addition to the aircraft parts manufacture, it maintained its line of automotive valves for some 50 different models of cars, trucks and tractors. An export division was added, and Thompson Aeronautical Corporation became a subsidiary, giving the first regular air passenger service between Cleveland and Detroit, Mich.

Pistons and pins supplemented the expanding product line in 1929. The first Thompson Trophy for an international land-plane race was awarded in the same year. Thompson products, by then well-known in the industrial, manufacturing and military fields, became familiar with all who were interested in air sports and travel. The company name became even more familiar when it issued the now-coveted limited editions of calendars reproducing Charles H. Hubbell's oil paintings of the trophy races and other important events in aviation history.



FOREMAN TO PRESIDENT

While still an electric welding foreman, Charles E. Thompson interested Alexander Winton in a welded valve for automobiles. A year later he became general manager of Electric Welding Products Company, the company that was to be later named Thompson Products, Inc., in his honor.



THE FIRST RED BRICK FACTORY

The photograph above was taken of the original Thompson Products Plant and shows it as it looked in 1901. At the time it was known as the Cleveland Cap Screw Company. Today, Thompson Ramo Wooldridge Inc. has plants throughout the United States and subsidiaries in Canada, Mexico and Brazil.

Expansion

The second out-of-Cleveland plant (the first being Michigan Welding Products Company, now known as Michigan Division) was Thompson Products Limited. It was founded at St. Catharines, Ont., in 1931. It remained the sole site of Thompson Ramo Wooldridge facilities outside the United States until recent months when subsidiary companies were formed in Mexico and Brazil.

Toledo Steel Products Company, another automotive-parts pioneer, was purchased in 1934, and its operations were transferred to Cleveland 10 years later. Today, the Toledo Steel Products Sales Division, found in major cities throughout the United States with the Thompson Products Sales Division, is the wholesale outlet chain for automotive repair parts. What is known as the West Coast Plant was originally Jadson Motor Products Company, Bell, Calif., complete control of which was acquired in 1937. Within the United States, the corporation had twenty plants before the merger and employed about 25,000 persons.

During World War II, Thompson Products once more became involved

in considerable defense work. The first contracts came from the English and French governments, and these were soon followed by air-defense orders from the United States. Further expansion was obviously necessary, and it had to be accomplished as quickly as possible.

Under agreement with the United States Federal Defense Plant Corporation, the company built a Government-owned facility at Euclid, Ohio—Thompson Aircraft Products Company (Tapco). Before Thompson Products purchased Tapco from the Government in 1954, it had become established as one of the country's most modern precision parts plants, a claim it still holds with pride.

Tapco turns out a wide variety of components for aircraft and missiles. Because of the varied nature and the relatively small quantities of the parts ordered from the facility, plant engineers recommended what is known as the colony system of production rather than the more customary assembly-line techniques. To make it function effectively, a basic air plant that could furnish general shop air at a nominal 100-psig pressure to all operational areas was necessary. Because there was a further need for high-pressure air to test completed components, satellite booster-compressor plants were strategically installed throughout the division. Next month, COMPRESSED AIR MAGAZINE will discuss this division in an article entitled *Tapco: A Portrait Of An Air Plant*. Particular reference will be made to its unique and diversified manufacturing operation as well as to the choice of compressors and the reasons for their installation.

Acquisition of Ramsey Corporation renewed the prewar expansion program; and the company reached out to include piston ring manufacturing facilities.

Far afield from transportation, but appropriately reminiscent of the late Charles Thompson's hobby interests, and following the company's policy of staying abreast of technological advances, the corporation entered the realm of electronic products. High fidelity amplifiers, tape recorders and public address systems became a part of the line with the acquisition of Bell Sound Systems, Inc., in 1953. Dage Electronics Corporation joined the family the following year, bringing television camera and monitor work, projection equipment and similar products with it.

The Merger

Meanwhile, in 1954, two scientists, Dr. Simon Ramo and Dr. Dean E. Wooldridge, turned to Thompson Products asking it to back an independent research laboratory they wanted to establish in Los Angeles, Calif. They received the necessary money in exchange for 49 percent of the common stock in The Ramo-Wooldridge Corporation.

The remainder was held by the two founders and certain key personnel. (Just prior to the merger, Thompson Products held 57½ percent of the common stock.)

The new affiliate grew faster than had been anticipated. Annual sales figures rose quickly from \$2,000,000 in 1954, to \$45,000,000 in 1957. In the first two quarters of 1958, before the merger, total sales were at the \$28,000,000 mark. Of its total business, 90 percent was military, and of that, better than 65 percent belonged to the Government's Ballistic Missile Management Program. Four years after it was organized, 60 percent of Ramo-Wooldridge's 3269 employees were working on the ballistic missiles program. As contracts continued to come from the Government, Thompson Products was asked to invest more capital. The parent company received an option to buy stock that would bring its ownership to 84 percent in a 2-year period beginning in 1962.

The rapidly changing nature of the company's product markets to more complex electronic and mechanical systems made apparent the advantages of merging the outstanding scientific and electronic talents of Ramo-Wooldridge with the vast manufacturing and production experience of Thompson Products. The two companies were merged late last year with the overwhelming approval of 99.7 percent of the shareholder ballots cast. With the establishment of the company headquarters in Los Angeles and Cleveland, the selection of a new management team and the approval of the shareholders, the new corporation was founded on October 31, 1958.

Like the two earlier reorganizations of the Cleveland Cap Screw Company and the Electric Welding Products Company, the newly formed firm picked a young management team. Chairman of the board is 53-year-old J. D. Wright, who had served as general manager and president until the merger. He is the chief executive officer, although he joined the company but 25 years earlier as an assistant to Crawford. Dr. D. E. Wooldridge, 45, who had already established himself as an outstanding scientist-administrator, was elected president. Simon Ramo, also 45, is the executive vice president. Horace A. Shepard completes the organization's nucleus as its 46-year-old vice president and executive assistant to Wright. He was the former operations vice president of Thompson Products, Inc. Others added to the staff bring the average age of the executive body to 40 years.

This was the first major management reorganization for Thompson Products in a quarter century, and it is management's hope that the new company will be able to keep pace with the space program as initiated by the Government.



FOR THE WINNER

One of the Thompson Trophies. The international land-plane races were first run in 1929 and were closely followed by sports enthusiasts. The trophy illustrated is for the "R" Division and bears the names of many well-known personalities: Charles W. Holman (1930), Lowell Bayles (1931), James H. Doolittle (1932), James R. Wedell (1933), Roscoe Turner (1934) and Harold Gurnea (1935).

The corporation feels that the space technology field is now a part of industry. Its guiding principles recall the history of the old company, and indicate its plans for the future:

"1. The company should continue its major position in electronics;

"2. The company is 'sold' on the automobile industry, and will increase its investment in the business; and

"3. The company will increase its emphasis on nonmilitary business while preparing for and taking advantage of military business, notably that of missiles."

(To Be Continued)

THE STORY OF ASBESTOS, PART II

Cassiar Asbestos Corporation Limited

PETER SLEIGHT

YOUNGEST of the Canadian asbestos mines, and the only one of major importance outside the eastern township mines of Quebec province and the Canadian Johns-Manville Munro mine at Matheson, Ont., is Cassiar Asbestos Corporation, Cassiar, B.C.

Asbestos, known to be in the Cassiar region for some time, was initially reported by prospectors who told of bands of mountain sheep bedding down on the soft, cotton-like fiber that had weathered out of the rock outcrops. Prospecting and development of the area was difficult

in the early days due to the lack of transportation facilities and the mountainous terrain.

Part of the present property was staked by four prospectors—Sittler, Nelson and two Kirk brothers—and their findings were soon acquired by Conwest Exploration Company, headquartered in Toronto, Ont. A pilot mill was erected in 1952, and a year later, a production mill was in operation with a rated capacity of 150 tons of ore per day. Conwest incorporated Cassiar Asbestos Corporation Limited in 1951 to develop and work the orebody and mine. Since then, the operation has expanded, and its present capacity is more than 1000 tons per day, or some 365,000 tons a year.

Cassiar Asbestos is doing exploratory work in the Yukon Territory near Clinton Creek, 40 miles northwest of Dawson, as well as in other locations in British Columbia.

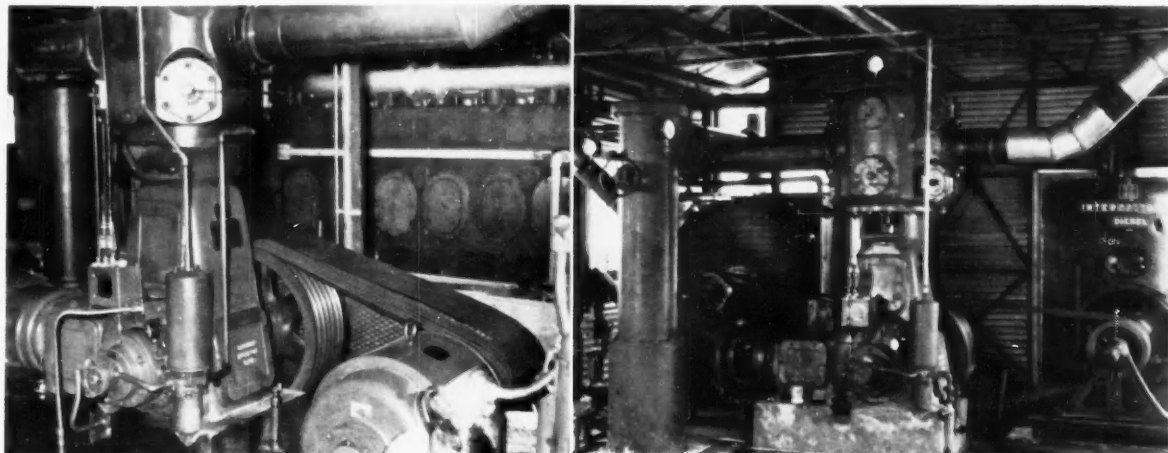
The Cassiar mine is located in the north-central portion of British Columbia, on McDame Mountain in the Cassiar Range. It is 86 miles southwest of Mile 648 on the Alaska Highway.

The nearest community for a long time was Watson Lake, at Mile 635. Now, however, another town has grown and bears the name of the mining company. It is located in a valley and provides Pan-Abode dwellings and bunkhouses for about 70 families and 170 single men. (Seasonal personnel are housed in prefabricated summer bunkhouses that have a total capacity of 231 men.) In addition to the living quarters, there is a cafeteria, a community club



LOCATION MAP

The Cassiar operation is located in the Cassiar Mountains at McDame Mountain in the northern portion of British Columbia. It is 1400 miles by road and 800 by air from Vancouver, where the bagged fiber is sent to be stored before being shipped to world-wide markets.



THE POWERHOUSE

Four stationary compressors are utilized at Cassiar. One is an Ingersoll-Rand XLE-2, 18½x11½x8½-inch unit driven by a 200-hp General Electric induction motor rated at 60 cycles, at 550 v. It furnishes air at a nominal 100-psig pressure for operating various pneumatic tools used throughout the mine area. The others are I-R XVH-B2 compressors. Two are of 15½x9x8-inch size (one of which is shown at the right). It is driven by an International

diesel engine rated at 172-hp, at 1250 rpm. It is a 125-hp unit with 3-step unloading control. Its Young cooler operates as a closed system, for the compressor has been installed at an altitude of 6200 feet and no water is available above 3500 feet. The other is a 11½x7x8-inch SVH-B2 and is shown in the close-up view at the left. It is a 75-hp unit that supplies air at a nominal 100-psig pressure for use in the bagging operations at the mill.

with a lounge, recreation hall, athletic field, a 2-sheet curling rink and a ski tow. Both Protestant and Catholic churches are located in Cassiar, and there is a company store, a branch of the Royal Bank of Canada and a detachment of the Royal Canadian Mounted Police. In a 6-bed hospital, one full-time doctor, a first-aid man and three nurses handle all but the most serious of cases. A subsidized employee construction program has resulted in the building of 30 privately owned family houses. There is also a public school for the first eight grades.

General manager of the Cassiar operation is J. D. Christian. N. F. Murray is the general superintendent. Other officials of the company are C. E. Bronson, assistant general superintendent; J. G. Berry, mine superintendent; A. C. Beguin, mill superintendent; A. C. Caron, chief engineer; R. R. Kirwan, equipment superintendent; R. A. Pasi-aud, mechanical superintendent; A. Pavlov, electrical superintendent; C. H. Hood, surface and construction superintendent; and R. L. McKenzie, general pit foreman.

The mine is located 3 miles from the town of Cassiar, and is operated from March to November of each year. Milling is done the year-round, the ore being stockpiled during the mining period in dry rock storage and outside stockpile areas near the mill.

During the summer the mining crew, consisting of 106 men, works three shifts per day, 7 days per week. They remove an average of 2500 tons of ore, and an additional 3000 to 5000 tons of waste each day.

In stripping the waste, or overburden, 75 feet are drilled per man shift. Using 0.31 pounds of powder per ton, an average of 683 tons of waste is broken per man shift—or 9.1 tons per foot drilled.

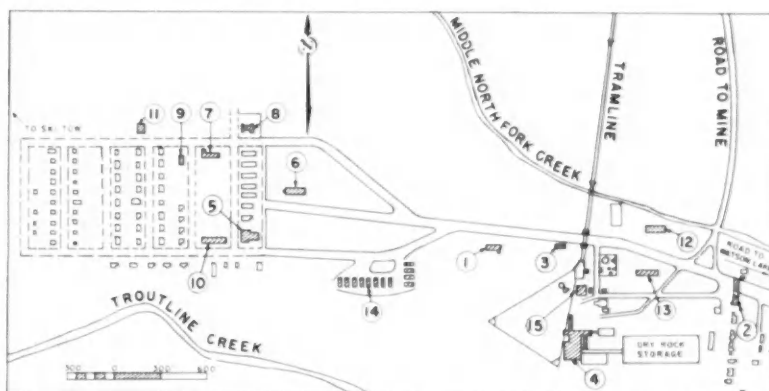
For primary blast-hole work in ore, each man shift results in 114 feet drilled, 547 tons of ore being loosed, or 4.2 tons per foot drilled. The powder rate is 0.31 pounds per ton. (The figures given for both the stripping and the primary blasting are based on 1958 averages.)

Geology

The orebody is at elevation 6200 feet on a spur from the western slope of McDame Mountain, 600 feet below the

peak. It is a large, lenticular body, measuring, where exposed, 400x800 feet, and consists of innumerable chrysotile veins scattered generously throughout the area. These seams vary in width up to 3 inches and constitute from 8 to 10 percent of the host rock.

There are three distinct formations within the Cassiar development, according to a report by Kenneth G. Donald, recently geologist at the mine. They are the Hidden Valley Group, the Sylvester Group and the McDame Intrusives, all of Paleozoic Age. The serpentinite is believed to represent the altered products of the McDame ultrabasic intrusions, which invaded the rocks of the Hidden Valley and Sylvester



CASSIAR, B. C.

Shown are (1) main office, (2) warehouse, (3) mine dry, (4) mill, (5) cookery, retail store and butcher shop, (6) hospital, (7) recreation hall, (8-9) churches, (10) curling rink, (11) school, (12) carpenter shop, (13) electric and machine shops, (14) summer bunkhouses and (15) powerhouse.



READY FOR OPEN-PIT WORK

Drilling En Echelon is accomplished easily with an Ingersoll-Rand Drillmaster. It drills 6½-inch-diameter holes, 60 feet deep on the top of McDame Mountain. The unit at right is working at an altitude of 6800 feet. Just to the rear of it is a 1000-foot straight-drop cliff. The illustration above is of the new Drillmaster that was purchased for the beginning of the 1959 mining season, foreground, and the older unit. Both are drilling 6½-inch, 40-foot holes in waste rock.

MOVING UP AN ACCESS ROAD

The Ingersoll-Rand Drillmaster, right, not only does its job easily because of its tracked mounting, but carries its own air supply system for more efficient and time-saving work. In the background can be seen a portion of McDame Mountain, Cassiar Range.



groups. The serpentine is generally apple to dark green or black in color, and is greasy. It is well blocked, and is occasionally well mineralized by veins of chrysotile asbestos.

The intrusions appear to have been made roughly parallel to the general structure of the sedimentary rocks; the strata below are generally dolomitic and carbonaceous limestone, slate and phyllite; and above, volcanic flows and tuffaceous argillites. For the most part, the asbestos is restricted to the blocky, green serpentine.

The sedimentary formation of McDame Mountain dips 30 to 45 degrees to the east, with only minor folding. The ore-bearing area generally occupies

the axis of the gentle fold of serpentine.

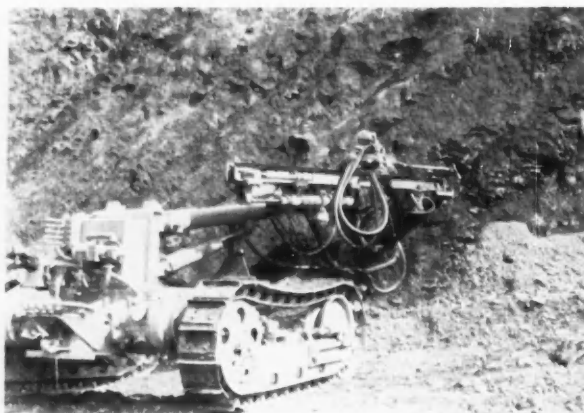
The folding indicates that the land underwent relatively minor distortion. Thus, the chrysotile veins grew gently, within channels that opened slowly, resulting in a long mineralization period. The veins therefore are wide and the fibers of long length, placing the ore high on the Quebec Standard Test scale. This makes the area of great economic and commercial importance, and has drawn considerable attention.

Mining

Because asbestos deposits are generally located close to the earth's surface, yet also extend far into the crust of

the earth, both open-pit and underground mining methods have been used in the older Canadian mines. In underground mining, the method used is block carving—the undermining of large blocks of ore so that the entire block caves or breaks down as a result of its own weight. Cassiar, being a relatively new mine, is being worked by the open-pit method. The small amount of underground work consists primarily of exploratory drilling, and should not be confused with underground mining such as is found in coal mines and similar ore-mining practices. It is more nearly similar to quarry work.

To delimit the orebody, exploratory drifting is necessary. Seven Ingersoll-



SERVING A DUAL PURPOSE

Because they are exceptionally mobile, these Ingersoll-Rand Crawl-IR's are being used for both exploratory work

and for making access roads as described in the text. The rough terrain can be seen in the background.



Rand J-40 Jackhamers equipped with JL-5 Jacklegs are used. These are light-weight for maximum portability, yet of sturdy construction to do the job at hand and cope with the terrain. Their movability is increased by the use of portable compressors for the air supply. Six JR-38 Jackhamers with JL-4 feed legs are also in operation. As the exploration program progressed, Cassiar brought a 2-drill ABJ jumbo, equipped with I-R DB-30 drifters and 4-foot-long aluminum power feed shells, from another property.

The mining was originally done *En Echelon* in much the same way as all open-pit quarrying is done. The first benches were of 15-foot size. Wagon drills, Eimco loaders, TD-14 tractors and International-Harvester trucks of 10-ton capacity were the principal equipment. As the tempo of the operation increased, a waste stripping program was required to free the ore. In late 1956, the benches were increased to 30 feet, with a 20-foot berm.

To free 8,000,000 tons of ore, 12,000,000 tons of waste must be stripped — a waste-ore ratio of $1\frac{1}{2}$ to 1. Additional equipment was required, including a $1\frac{1}{2}$ -yard Northwest shovel for ore work, and a $2\frac{1}{2}$ -yard-capacity one for waste work. To haul the material, six Model 802, 16-yard Kenworth trucks are required.

To keep the rapidly increasing pace of production, a Canadian Ingersoll-Rand DM-3 Drillmaster, with a DHD-325A Downhole drill, was purchased. It supplemented equipment already in use, notably track-mounted percussion drills using $4\frac{1}{4}$ -inch Carset bits.

The Drillmaster is equipped with a $6\frac{1}{2}$ -inch Carset bit, enabling the use of 5x16-inch Dynamex cartridges for

blasting. (Prilled ammonium nitrate and fuel oil is also being utilized as a blasting agent in an effort to maintain production costs at a minimum.) Holes were put down 33 feet, 3 feet being sub-grade drilling, and were spaced $16\frac{1}{2}$ feet apart with a 15-foot burden. Checked over a 2-month period, the Drillmaster averaged 100 feet per drill shift, resulting in 1465 tons of broken rock, or 14.5 tons per foot drilled. Powder required amounted to 0.33 pounds per ton. A second Drillmaster was ordered for the 1959 mining season and is illustrated on page 14.

For secondary ore drilling, roadwork and the like, an Ingersoll-Rand Crawl-IR is being used. It is especially suited for the steep, rough terrain; and because of its tracked mounting, it can get to the jobs at hand quickly and efficiently. It drills either 3- or $3\frac{1}{2}$ -inch holes using Carset bits. According to reports from the mine, when working on the access roads, it broke 1.9 tons

for every foot drilled. Powder rate was 0.46 pounds per ton.

After blasting, the ore is transported by Kenworth trucks to a grizzly and primary crusher where it is reduced to 4 inches and dropped to the head of a tramline by conveyor and chute. (During the summer months, some truck haulage is necessary to supplement the tramline haulage to the mill.) Originally, all the ore was brought by means of trucks over a 6-mile-long road. Then, from 1953 to 1955, it was transported from elevation 6200 to 4800 by a flight conveyor within a steel chute. At elevation 4800, it was loaded into 10-ton International trucks for the rest of its trip down the south face of McDame Mountain. This system was abandoned in favor of the aerial tramline that is currently in operation.

The tramline was manufactured and installed by British Ropeways Engineering Company Limited. Construction began in 1954, and two operation seasons were required for its completion, or 10 months of actual working time.

From the upper loading terminal, at elevation 5800, to the lower station at elevation 3525 feet, the line runs 14,600 feet. It is in two principal sections with a third, or unloading section travelling in a loop around the outside storage area near the mill. The system moves about 2000 tons of material per day. It is equipped with 160 buckets, each of 18-cubic-foot ($\frac{3}{4}$ -ton) capacity. During the operation of the tramline, approximately 100 kw is generated by dynamic braking.

Milling

The basic phases of milling asbestos are stage crushing, drying, surge storage



LOOKING DOWN

This aerial view shows the chute and mine from the top of McDame Mountain in B. C. On top is a DM-3 Drillmaster drilling 60-foot-deep $6\frac{1}{2}$ -inch-diameter holes. The picture was taken in the fall of last year.



DOWN THE TRAMLINE

Looking toward the mill from the mining area. In the background can be seen some of the mill buildings and McDame Mountain.

to smooth out variations in feed, successive air aspiration, and crushing or fiberization to remove the fibers as soon as liberated into a series of concentrates; cleaning and grading of these concentrates into selling grades; and blending and bagging of the various grades for market.

Ore as received from the tramline is again crushed through a 4-foot Symons Cone Crusher and is reduced to 1½-inch size. This ore is then dried in rotary, oil-fired kilns. It is next de-

livered by conveyor to a 110,000-ton-capacity dry rock storage building of Bailey Bridge construction. A tripper is used for feeding and multiple draw points for reclamation. This system, it is reported, provides fairly uniform mill feed.

The ore is withdrawn from storage by electric feeders, controlled in a centrally located operator's booth within a mill building. It is conveyed past a magnet to remove tramp iron and fed to primary screens where any free fiber

is aspirated through a hood or nozzle that extends the full width of the screen, in the manner of a large vacuum cleaner. Ducting carries the fiber-laden air to a Cyclone collector where the fiber load is released through a rotary valve. This fiber may be described as concentrate number one.

Dusty air passes through the exhaust fans into a plenum leading to an air filtration unit. The ore then goes to a gyratory crusher for further reduction, screening and removal of available fiber. Fiber removed at this stage represents the second concentrate.

The ore is then put through a fiberizer, a type of hammer mill, that opens or fluffs-up fibers so that they will be amenable to aspiration. Further screening and aspiration produces a third concentrate.

Exhausters fans handle more than 130,000 cfm of air in this aspiration process. This air, after it has served its primary purpose, is filtered through Wheelabrator dust collectors (filtration unit) and is recirculated as part of the operation's heating system. As the filtration unit removes virtually all dust, this system of recirculation maintains uniform working temperatures in the mill the year-round.

Grading

The three concentrates just removed are then cleaned to make individual grades. Cleaning is effected by cascading the fiber over a series of oscillating screen decks equipped with cloth sufficiently fine to make an economic rejection of dust or fine fiber elements. This is usually in the 20- to 50-mesh range.

Graded fibers are then aspirated for final removal of fine fibers or dust and are then deposited into their respective bins. After a batch has been tested and is found satisfactory in quality, the lot is bagged in 100-pound Jute bags by means of pneumatic bagging machines. After bagging, the bags are stacked on pallets and are removed by fork-lift trucks to the fiber storage shed.

Samples from each bag are composited to represent a certain lot of production, usually a shift, and a sample tested in the laboratory. Equipment there consists of Quebec Standard Shaker screens, a Ro-Tap machine, wet classifiers, cotton bombing apparatus, surface area and filterability measuring equipment, and a VU-Graph.

The lot tested may be rejected or passed for shipment, depending upon results of tests performed. Since the fibers leaving the plant may receive no further processing before being put to use directly in the manufacturing industry, this quality control for uniformity is essential.

The highest quality spinning fiber produced at Cassiar is called Cassiar No. 1



READY FOR WINTER

This pile of asbestos ore is being stocked for the winter operations. Because of the climate, mining can only be carried on from March to November. Milling goes on throughout the year, however, utilizing excess ore stored during the summer months in this outside area and in a rock storage area.

WORLD ASBESTOS PRODUCTION *

	1952	1954	1956
CANADA	929,339	924,116	1,014,229
UNITED STATES	53,864	47,621	41,312
TOTAL: NORTH AMERICA	983,203	971,737	1,055,541
SOUTH AMERICA	2,800	4,000	9,500
EUROPE	290,000	300,000	305,000
ASIA	25,000	33,000	37,000
AFRICA	255,064	211,088	287,477
OCEANIA	5,310	5,279	10,225

*In short tons, according to "Minerals Year Book," published by the U. S. Bureau of Mines.

WORLD PRODUCTION

The table above was abstracted from a recent "Minerals Yearbook" that is published by the U. S. Bureau of Mines. The recent rising totals are obvious, as is the fact that Canada is, and has been, the world's number one producer of the magic mineral.

Crude. It is used for the manufacture of high-quality textile products.

Spinning fibers are also produced and are rated, in order of descending value, as AAA, AA, or A. These are used for woven friction materials; fire protection clothing such as gloves and suits, fire curtains for theaters, ironing board covers, motion picture theater booths, screens and floors; gasket material; supersonic missile components; padding in prison cells; and in laboratories for such items as Gooch crucibles.

The other fibers produced at Cassiar are called Shingle and Asbestos Cement fibers, and are graded, in descending order, AC, AK, AS, and AX. They are used in molded friction materials; flat and corrugated siding and roofing, pipes for water, steam, sewage, conduit, columns, chimneys and the like; and as filters for breweries and chemical plants.

Tailings are discarded along a system of conveyors. A high-speed swivel "piler" disposes of the tailings in fan-shaped piles.

Foreign material in asbestos is harmful to delicate cording and spinning equipment used by manufacturing concerns who process the bagged asbestos into finished products. Consequently, great care must be exercised that such materials are not introduced into the ore at any stage of the mining or milling operations. When it was learned that such items as wood, blasting wire and tape fuse were going through to the customer, their use was discontinued. Primacord has replaced electric or fuse blasting and wood serves no purpose in the mining methods presently used at Cassiar Asbestos Corporation.

A fleet of company-owned diesel semi-trailer vans transports the fiber to Whitehorse, where it is transferred for shipment by rail to Skagway and by boat to Vancouver, B. C. The fiber is stored

in large dockside warehouses in readiness for shipment to industries throughout the world.

Statistics

Although Canada is the world's greatest producer of asbestos, she has few industries that use the mineral to produce manufactured goods. The United States is the number one importer of asbestos; and the chief exporter of asbestos products. She uses about 60 per-

cent of Canada's total export. Western Europe is the second largest market for Canadian fiber, and is followed by Japan, South America and Australia.

Canadian shipments for 1957, according to the Dominion Bureau of Statistics, totalled 1,046,086 short tons for a total value in excess of \$104 million. This can be favorably compared with the figures for the preceding year, during which time 1,014,229 tons with a value of about \$99 million were shipped—an increase in quantity of 3.1 percent, and of value, 4.6 percent. However, the 1958 figure showed a decline to 925,670 tons shipped.

The asbestos mining industry is not a small one, either at the individual mines or as a whole. In Canada alone, it employs more than 7000 persons who are paid wages amounting to more than \$30 million. The net value of production, that is, the gross value less the costs of fuel, electricity, process supplies and containers, amounted to more than \$90 million (1958), a figure that has grown by more than \$80 million since 1937. In market dollar value, the asbestos industry in Canada reached an all-time peak in 1957 of approximately \$106 million. The mineral industry as a whole represents a figure of \$1.578 billion; and in analysis, the dollar value of the asbestos industry is greater than that of coal, cement, lead, silver and zinc mines. It was only \$24 million below the rapidly expanding uranium business in 1957, but last year, increased uranium production widened the gap by nearly \$200 million.



MINE PERSONNEL

Lower Row, left to right: I. G. Berry, mine superintendent; M. Dopson, mine captain; N. F. Murray, general superintendent; and C. E. Bronson, assistant general superintendent.

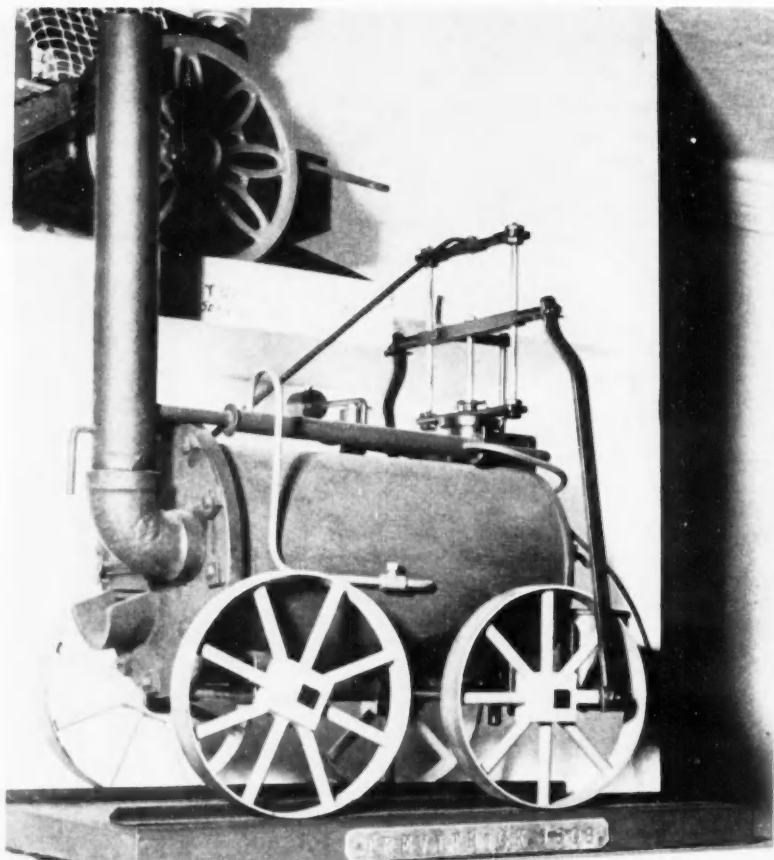
Second Row, up the steps: R. Stevens, purchasing agent; R. A. Pasiand, master mechanic.

Third Row, left to right: C. Hood, surface superintendent; A. C. Caron, chief engineer.

Fourth Row, left to right: C. Cobb, doctor; P. A. Davies, safety engineer; W. Johnson, accountant.

Toy Steamers Of A Day Gone-by

✿ HENRY C. SUTER ✿



LOCOMOTIVE

Above is a model of a locomotive, 1808 vintage, that once chugged across the English countryside. It is a copy of one designed by an English engineer and inventor, Richard Trevithick (1771-1833), who built a road locomotive that carried the first passengers ever transported by steam.

GREVILLE BATHE is a 75-year-old retired mechanical engineer who, in this age of satellites, atomic submarines and missiles, enjoys his hobby of building and collecting scale-model steam engines that served man in bygone eras. At his home in St. Augustine, Fla., Bathe has accumulated some 800 of the toy engines and has built about 50 more himself, a collection that can safely be rated as one of the largest in the world.

The midget engines range from the smallest oscillating type, about 4 inches high, to vertical ones 18 inches tall. Among the 50-odd models he has constructed are a steam cannon, a steam mine engine, early locomotives and a steamboat. He also built a model of a rotary-motion steam turbine, first designed and constructed by Hero the Greek in 1200 B. C. All of Bathe's miniature engines are fashioned to scale

and all are working models. However, since it usually would be impractical to start the miniature fires under the small boilers, Bathe has three air compressors that supply air to drive the models. Neatly arranged on shelves and tables that extend from the floor almost to the ceiling, the tiny engines occupy two rooms in the engineer's home and are beginning to overflow into a third.

Bathe started his hobby in 1936 after retirement from active business, but says his fascination for toy steam engines

dates from 1887, when as a boy living in Cambridge, England, he received one as a Christmas gift from his father. "Up until the first World War," he states, "the steam engine was a favorite toy for mechanically minded boys—as much so as the model airplane and electric train of today."

Some of his fondest boyhood memories are of the tiny sputtering and cracking sounds of little boilers earnestly building up steam pressure to put tiny drivers into operation. Bathe's early interest in the steam engine led him to enroll in the London Polytechnic Institute where he majored in mechanical drawing and steam engineering. After serving an apprenticeship, he began his own business in 1906 to build small internal combustion engines.

In 1919 he went to America and settled in Philadelphia, Pa., where he man-

DA VINCI CANNON

Among Leonardo da Vinci's many accomplishments was the design of a cannon that fired a projectile with steam. Bathe followed a reproduction of Da Vinci's own drawings to build this model, then watched the tiny weapon fire a BB across the room.



ufactured small machinery and inventor's models until his retirement. He moved to St. Augustine in 1948.

Examples of his engineering work are on display in the Franklin Institute's museum and the Atwater-Kent Museum in Philadelphia. His career also has included writing a number of engineering books, his latest being *An Engineer's Notebook*, written in 1955. It is an engineer's miscellany on biographical, manufacturing and mechanical subjects.

Nearly all the models Bathe owns were collected for him by an agent in

Cambridge, Mass. The agent usually comes upon the little engines in antique shops and then sends photographs of them to Bathe. If he likes a newly found toy, Bathe instructs the agent to buy it.

When he is constructing scale-model engines, Bathe can consult data from a large collection of early books dealing with mechanics and steam engineering. (His library, one of the largest of its type in the world, has been bequeathed to Swarthmore College, Swarthmore, Pa.) In construction of the toy steam

gun, for example, Bathe followed a reproduction of a diagram drawn by Leonardo da Vinci. "I became interested in determining if the gun would work," he says, "so I built the scale model based on the diagram from the old book. Sure enough—it fired a BB pellet across the room."

Bathe constructed a model of Captain Samuel Morey's steamboat, of 1790 design, from a brief description in one of his library volumes. The Morey vessel's paddlewheel was attached to the bow and driven directly by a crank mechanism. According to Bathe, it was operated successfully by Morey long before Robert Fulton commercialized the steamboat.

Bathe frequently must resort to ingenious uses of materials not usually associated with steam engines, toy or otherwise. "I am a great collector of things that I feel can be used in construction of the models," he states. "They are made primarily of wood but many of the boilers are fashioned from discarded meat and beer cans." Wheels for some of his locomotives came from children's vehicles given to him by neighbors, and he used the plate of an automobile clutch to put one of his models into operation. An interesting innovation was the adaptation of the copper float from a toilet reservoir to reproduce a model of an early Greek turbine. This turbine is the first known use of steam as a power source.

Most unusual of Bathe's models, perhaps, is one of a machine perfected by Branca of Italy. Used to crush paints and drugs, it is in the form of a man's head and has steam emitting from pursed lips.

MINING ENGINE

Bathe adjusts a screw that anchors the flywheel of this antique, steam-driven mine engine. The machine itself dates from 1820, though the replica shown here is one of Bathe's recent creations. Some 850 various steam engine models fill two of his rooms and are spilling into a third.





This and That

Operation Button Jar

To obtain needed equipment for scientific laboratories in universities, Operation Button Jar was begun in Cleveland, Ohio. The idea was originally that of Resse & Miller, Inc., a firm that specializes in the preparation of technical literature. It is now being conducted in conjunction with Case Institute of Technology as a public service, with no charges being made to either colleges or industries. Its purpose is to gather discarded material and equipment from industry, reclassify it, and distribute it to colleges where it can be put to good use in laboratories. Founders of the project know that such odds and ends are needed, but often are not considered in ordinary academic budgets; at the same time, industry scraps tons upon tons of such items annually. The name of the project comes from the old fashioned household button jar that was a vital reservoir for the housewife as her main source of odds and ends so necessary for the proverbial stitch in time. The range of the new button jar is broad, including everything from nuts and bolts to relays and vacuum tubes. The material will be distributed to an equally wide assortment of academic laboratories—mechanical, electrical, chemical, physical, hydraulic and electronic. Manufacturing rejects, product samples and discarded plant equipment are thought to be the most fruitful sources.

★ ★ ★

Additional Power At Wilson Dam

Three new power units for Wilson Dam, on the Tennessee River near Florence, Ala., are now under construction. It is estimated that they will generate 162,000,000 kwh annually. This will add 162,000 kw of peak capacity to the Wilson Dam power plant. The estimated cost of the new units, \$24 million, was economically justified, since the annual cost per kilowatt of dependable capacity is estimated at \$5.40, whereas the value assigned by the Tennessee Valley Authority to dependable peak capacity for economic appraisal is approximately \$10 per kilowatt per year. The three units are expected to be completed in 1961

a year after the start of construction on proposed installations at Wheeler Dam, located 15 miles upstream from Wilson.

Construction of the Wilson Dam project was authorized in 1916 and completed in 1925. The present system consists of eighteen units aggregating 436,000 kw. Eight power units had been installed in the plant when the TVA took over in 1933, and the remaining ten were installed by the Authority in the 1942-50 interval. The size of the TVA power system has now reached such magnitude that relatively large additions of either energy or capacity can be readily absorbed by adjusting steam generation. The electric load of the TVA service area is currently increasing about 750,000 kw annually. The total system load for 1958 was in excess of 61 billion kwh, equivalent to nearly 7,000,000 continuous kw.

★ ★ ★

Aussies' Hocus- Pocus

Billy Hooker is the tribal rain-maker of the Borooloola aborigines in the wild gulf country of Northern Territory, Australia. Some time ago, he put in some meteorological overtime and precipitated a flood. His enraged tribesmen threw him and his rain-making stones into nearby McArthur River. Yellow Fred, an up-and-coming medicine man, in an attempt to salvage Hooker's business failure, offered to buy Billy's rain-making secrets, but when Fred produced only half the asking price, Billy retained half the stones and used them to block Fred's magic. It is interesting to note that in the period following the Billy Hooker-Yellow Fred skirmish, Darwin's rainfall was only about one-third of its usual 15 inches.

★ ★ ★

Flying Stove- Pipes

Flying stovepipes may power tomorrow's supersonic passenger planes. Ramjet engines, which gained the stovepipe nickname from their cylindrical shape and simple interiors, are now used to power guided missiles and experimental aircraft. Their more complicated cousins, turbojets, dominate the aircraft propul-

sion field. In a turbojet, incoming air is compressed by a gas-turbine powered fan. In a ramjet, air is scooped into the engine as the aircraft pushes through the atmosphere. Since ramjets will, therefore, be useless unless the aircraft is already in motion, future airliners will probably be equipped with turbojet boosters to get the craft off the ground efficiently, and ramjets to power it at high cruising speeds. Factors in favor of ramjets are their more economical operation at high speeds, simplicity of design, elimination of complex control and lubrication systems, greater reliability with fewer moving parts, and a high safety factor.

★ ★ ★

Roe Fly SAS

Five thousand would-be salmon, in the form of fresh roe from Lake Vanern, Sweden, were shipped from the fish-breeding institute at Dejefors, Varmland, to the United States. The eggs made the journey via the famed Swedish airline, SAS, and were kept at temperatures ranging from 32° to 50° F. Their destination was the U. S. Fish & Wildlife Service breeding station at Leadville, Colo., where they are being used for experiments. This particular breed of salmon differs from other species in that it is a land-locked variety. The fish have no means of swimming to the sea because they cannot pass the dam-regulated tributary of Göta Alv.

★ ★ ★

Cripple Creek's History

"... the memory of them is forgotten ... neither have they ... a portion for ever of any thing ... under the sun." These words from Ecclesiastes are from the dedication of a new book, *Forgotten Men of Cripple Creek*, which is subtitled *A Story of the Mount Pisgah Gold Excitement*. The authors, Leslie Doyle Spell and his wife, Hazel M., have attempted to preserve the flavor of this Colorado town that holds a special place in American gold mining history. Spell spent his boyhood and young manhood in the district, and in each of the eighteen chapters, tells a new tale about the Cripple Creek area, where gold mining activity reached its height in the late 1800's. Spell is well qualified to comment on mining. He worked for many years as a gold prospector before turning his interests to rare earths and building stone. At a Death Valley '49er Encampment in 1955, Spell, pack burrow in tow, won first prize for his representation of the most authentic old prospector. For the person fascinated with early mining tales and equipment such as the famed Leyner drills, this book about Cripple Creek

(where a letter from England addressed "Lame River, Colorado" is said to have actually been delivered) is worthwhile reading.

★ ★ ★

The New Look

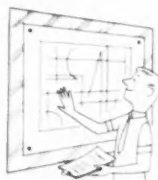
Blueprints have an unusually strange look at the Industrial Office of United Aircraft Products, Inc., a 30-year-old, aeronautical

engine accessory manufacturer in Dayton, Ohio, because their original condition is changed but slightly. Tired of handling dog-eared and corner-torn blue-



prints that have suffered the ravages of thumb tacks, sticking tape, dirty hands and the usual rough treatment given them in any active shop, chief process engineer Robert Huesman

and master mechanic Harry Gersbacher devised the new approach. They installed six 48x72-inch panels of stainless steel on the walls of the drafting room. The blueprints are fastened to these sheets by means of magnets. The panels are made of Allegheny Ludlum Steel Corporation's Type 430 stainless sheet. According to United Aircraft engineers, with the new system it is easy to see the drawings from any part of the room. More important, however, the prints are preserved in nearly their original state, making working with them a more pleasant routine.



★ ★ ★

Heat- Stable Plastics

Chemists of American Potash & Chemical Corporation have synthesized a new molecule that possibly will lead to the development of heat-stable plastics. The new compounds are based on boron and phosphorus and are known chemically as phosphinoborines. (Most existing plastics are composed of carbon compounds; a few are based on silicon-and-oxygen combinations.) The majority of today's plastics are stable only to approximately 300° F, but it is hoped that the new materials will withstand temperatures to approximately 750° F. To date, the scientists have developed two basic types of new plastic, one a translucent milky compound that is heat resistant but too brittle, and another with appearance similar to existing plastics but with little heat stability. Added research is necessary to combine the desirable properties

of the two—plasticity and heat stability—into a useful product. The new materials are the result of 4 years of research by American Potash & Chemical Corporation in cooperation with the U.S. Air Force at Wright Air Development Center, Dayton, Ohio. The air arm is supporting a broad program of research to develop new high-performance materials required in today's supersonic and advanced air weapons.

★ ★ ★

Power For The Dakotas

A \$1,524,647 Bureau of Reclamation contract for stringing aluminum conductor from Fargo, N. D., to Granite Falls, Minn., a distance of 165 miles, has been authorized by the U. S. Department of the Interior. The contract was awarded to Midland Constructors, Inc., Chicago, Ill., low bidder among twelve. (The high bid reached the \$1,749,998 figure.) The 23-kv, 3-phase, 60-cycle, single-circuit, steel-tower transmission line from the Missouri River Basin Project will be an important link in the system to send electric energy generated at Federal dams on the Missouri River to power customers in the Dakotas and western Minnesota. The contract calls for furnishing all material and stringing three conductors and two overhead ground wires. Work at the site will start about September of this year and is scheduled to be completed in 370 days. The steel towers are currently being erected under another contract that was awarded 2 years ago.

★ ★ ★

More About Reservoir Protection

The U. S. Department of the Interior has released data learned about conserving reservoir water by applying a monomolecular "chemical shield" to slow evaporation. (Preliminary studies were described in an article entitled *Reservoir Protection* in the April 1958 issue of COMPRESSED AIR MAGAZINE.) A savings of 9 percent was achieved during the July-September test on Lake Hafner, a 2500-acre body of water in Oklahoma. Conditions for the test were described as difficult because wind and rain breakage of the film made maintenance of a cover not an easy task—the average cover on the lake was only about 10 percent. About 800 pounds of dry-powdered hexadecanol were applied during each of the 55 days when spreading of the chemical was feasible during the 3-month test. Determination of the water saved was possible because the lake is one of the few reservoirs where water flowing in and out can be precisely measured. No ill effects were observed to have resulted to plankton, most aquatic

insects, fish, frogs, turtles, ducks, shore birds, small animals and other inhabitants of the water. The only problem seen was that insects which depend on the normally higher surface tension of untreated water, drowned when the hexadecanol reduced this tension. Water temperatures increased as much as 3° F because of the reduction in evaporative cooling. The water saved by the experiment was done so at a cost approximately equal to the value of the water, but because conditions were far from ideal, it is thought that under full-scale operation programs, this expense would be reduced considerably. Numbers of microorganisms present in the water increased, but the water, after purification, met Public Health Service drinking water standards.

★ ★ ★

Hapless Gold Find

An old Forty-niner would never believe it, but there are times when the discovery of gold is bad. Specifically, the metal can be a contaminant for high-alloy steels if the gold is mixed in a batch of scrap purchased for remelting. The manager of Allegheny Ludlum Steel Corporation's Scrap & Salvage Purchases Department has told of an instance where unwanted traces of gold appeared in a truckload of Type 18-8 stainless steel scrap. The source of the metal seems innocent—the gold tips of stainless steel fountain pen points that had been scrapped from a production line. Unfortunately, it is of considerable consequence. Because costs per ton of steel produced "snowball" with each successive rolling and mill operation, steel that must be scrapped after several operations because of unsatisfactory surface conditions, caused by such contaminants as gold, represents a costly loss.

★ ★ ★

Explosion Detector Designed

What seems to be a novel device to warn of danger of explosion has been reported by the Swedish press. Designed by a team of engineers at Salen & Vicander AB, the device is based on the principle that platinum reacts as a catalyzer when it comes into contact with explosive gases. The flame-protected and capsuled center of the new instrument is a platinum filament serving as a conductor for an electric current. When it is exposed to explosive gases, such as hydrocarbons, the electric resistance will change, these data being transmitted to an electronic center from where the impulses can be made to actuate acoustic or visual alarm apparatus. The electronic center can be located as far as 3000 feet from the detector, it was reported.

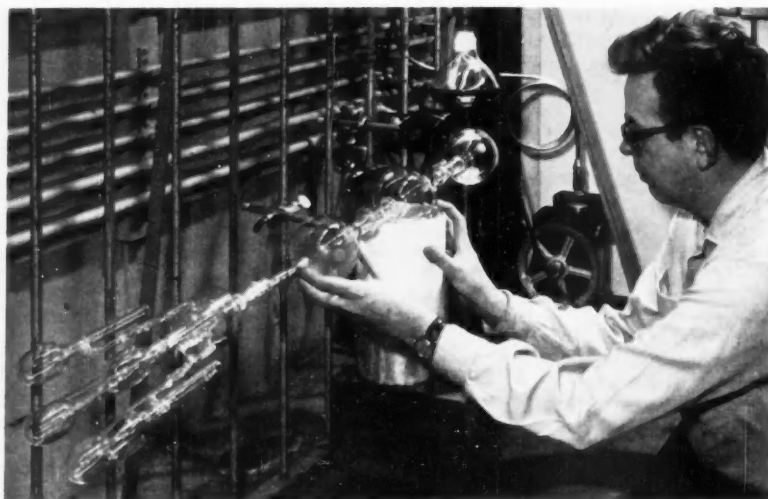
**Rapid and efficient separation
of high boiling point materials
is made possible with this—**

MOLECULAR STILL

A SIMPLE rotating molecular still, designed at the U. S. National Bureau of Standards, makes possible the separation and purification of high boiling point materials by distillation. Operating at low temperatures, the still separates materials rapidly and efficiently without exposing them to severe thermal decomposition. It should be especially useful in petroleum research where various distillation techniques are applied in studying by-products, and in biochemical and pharmaceutical work as a purification technique.

Generally the rotating evaporators and molecular stills that have been developed in recent years have some disadvantages in their complex construction. For example, rotating evaporators, when used as molecular stills, are unsatisfactory in that the system either cannot be evacuated to the required low pressure, or, if lubricated joints are used, the lubricant may contaminate the sample. This type of apparatus is not readily adaptable to multiple stages for distillation. On the other hand, molecular stills that make use of mobile films operate with an enclosed system but are quite complex and more expensive than the rotating evaporators.

The newly designed molecular still, however, can be readily constructed and easily operated. The essential features of the still (as indicated in the drawing) include two or more 500-milliliter glass bulbs connected in series, one or more glass ampoules, an infrared lamp, a Dewar containing a refrigerant, and a motor for turning the apparatus. When in operation, the axis of the apparatus is inclined about 10 degrees from hori-



A NEW STILL DESIGN

A simplified rotating molecular still (center), designed at the U. S. National Bureau of Standards by G. S. Ross and L. J. Frolen, is used to separate chemicals that have high boiling points. Besides providing simplicity of design and ease of operation, the apparatus separates these materials more rapidly and efficiently than conventional methods using molecular distillation.

zontal. The glass bulb at the high end serves as the container for the sample and the remaining bulbs act as collectors of the distillate. The glass ampoules in which the distillation fractions are bottled are attached at the lower end of the apparatus.

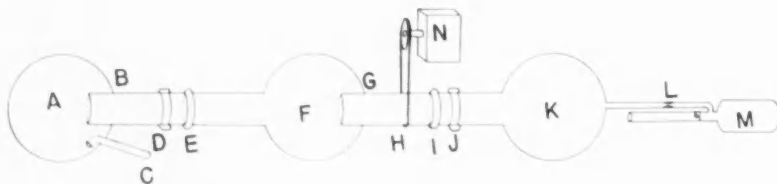
As the molecular still rotates at 1 to 2 rpm, the test sample continuously forms a thin surface film on the wall of the container. The infrared lamp heats the film, causing molecules to evaporate from the film's surface. This technique

has an advantage in that the bulk of the test sample remains cool, thereby limiting thermal decomposition. Under normal operation, the sample is only a few degrees warmer than room temperature.

Gradually the vapor flows toward the adjacent collecting bulb, where it is condensed. The low temperatures are produced in a wide-mouth Dewar flask containing liquid nitrogen or a slurry of solid carbon dioxide in carbon tetrachloride and chloroform. The Dewar flask is placed directly under the collecting bulb.

Repeated distillations can be performed in the same manner by shifting the infrared lamp and the Dewar flask to the adjacent bulbs. After the distillate melts, it is drained into a glass ampoule which is then sealed off and removed.

The new still has been used to remove color impurities and high-molecular-weight oxidation products from such materials as the halogenated or alkylated dimethylanilines and analogous anisoles. Further, high-boiling residues from crude chlorinated ethyl-benzene stocks have been successfully purified with this apparatus.

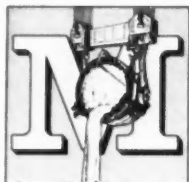


REFERENCE DRAWING

This still is inclined about 10 degrees from horizontal during operation. Its components consists of 500-milliliter bulbs (A, F, and K), rings (B and G); and entrance tube (C); band clamps that are used as bearings (D and I); aligning protrusions (E and J); a rubber O-ring (H); a sealing constriction (L); one or more ampoules (M); and a motor (N).

EDITORIAL

The Minor Metals



ETALS make up the majority of known elements. Indeed, one classification of elements assigns but 21 substances—the eleven that are normally gaseous plus boron, carbon, silicon, phosphorus, arsenic, sulphur, selenium, tellurium and iodine as well as the liquid bromine—to the nonmetallic category, the remaining 80-odd being classed as metals. Many of these are well known to all and constitute in many respects the very building blocks of our civilization. Aside from the rare and valuable ones that form the basis of our monetary system, the importance of such as iron, tin, aluminum, zinc, copper and many others need not be expressed. Even uranium and thorium, the stuff of which our atom age is made, are metallic in nature.

The layman is familiar to a large degree with those metals, used in their elemental form, as part of his automobile or home appliances. He is also conversant with a few of the more common alloying metals such as manganese and molybdenum. Totaling up all of these, however, finds us still many short of the more than 80 different metals; even subtracting those that have been created by man in his atomic research, and that last but briefly, still leaves a number that are classed, for the sake of convenience, as the rare or minor metals.

Many of these are no longer minor in importance. If they do not receive public recognition it is largely because their total production is hardly a drop in the bucket as compared to iron and aluminum. Output of some of the more rare members of the group can be measured in pounds—not on an annual basis, but as a total quantity. Yet in the fields of electronics, rocketry, atomic energy and a variety of others, and in the realms of solid state physics and molecular chemistry, their influence weighs much more heavily than their mass would indicate. (Perhaps costs give a more precise indication of their worth: one such metal—cesium—selling for about \$5 per gram, and others being priced at tens and even hundreds of dollars per gram.)

APPLICATIONS of the minor metals are growing as engineers indicate needs for elemental and alloyed metals having superior properties at

widely varying temperatures, as science points the way to more "breakthrough's," as chemists and physicists learn to use some of these rare metals' rare properties. Cesium, for example, as a plasma thermocouple, has received a great deal of attention for the relatively high efficiency with which it converts heat directly into electricity. Both cesium and rubidium are finding applications in piezo-electric devices as well as in exotic fuels for rockets. The rare earths are now in plentiful supply because their principal ore—monazite—often accompanies thorium deposits. Use of these once scarce elements as alloying agents now looms on the horizon of metallurgy and promises steels, aluminums and perhaps even brasses more adequately tailored to new jobs.

OUT OF the basic research into rare metal properties may come new primary metals of tomorrow. Nickel was once considered a minor metal—now, with an annual world production estimated at about 310,000 short tons it can hardly be classed as minor in volume or importance. A more recent example is titanium, which is not only readily available on the market today, but is beginning to compete from a standpoint of price with some special alloys. Prior to World War II titanium was definitely in the class of the minor or rare metals. Others such as beryllium, cadmium, columbium, tantalum and vanadium are steadily growing in importance.

EDITORIALLY speaking, we think it is of interest to note that most of these "new" metals now winning acceptance are wrested from the earth in the same way as the more prosaic "old" ones—compressed-air-powered rock drills, air compressors, mine ventilating blowers and dewatering pumps, explosives, drill steel and bits are all utilized. In addition, many of these metals are so highly reactive at forming and extraction temperatures that they must be enclosed in blankets of inert gases or even melted under high vacuum in order to make them useful. We find in the minor metals not only the promise of great engineering steps in the future, but growing markets and more rigorous operating conditions for the equipment that generates and uses compressed air and gases.

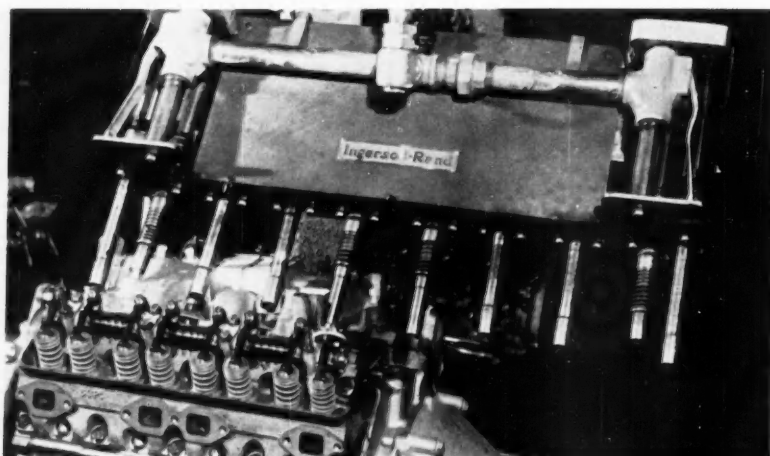


SAVING WITH AIR POWER

Application: Engine Assembly

ONE operation of the engine division of a major automobile manufacturer is the tightening of ten bolts that secure the intake manifold to the cylinder head. Because the bolts are arranged so that all ten can't be tightened simultaneously, it appeared that two multiple nut runners and two operators would be needed. This method would provide an improvement in quality over the old practice of using single-spindle angle wrenches, but there would be no direct manpower savings—a tool operator would still be required on each side of the assembly line.

An Ingersoll-Rand Multiple Nut Runner was designed specifically for the operation and installed in the engine manufacturing plant. This tool consists of two 5-spindle tools fastened together. A throttle at one end controls one bank of spindles, and a second throttle at the other end controls the other set. The operator (with the new machine only one operator is needed) stands at the rear of the engine and runs down the right-hand set of five bolts by actuating the front throttle. Then he rotates the whole tool 180 degrees about the vertical axis, tightening the left-hand bolts by actuating the other throttle.



This creates a real saving. With the old method using two operators per line, 180 finished units were completed in a day's 16 hours of work (two 8-hour shifts). With the I-R Multiple Nut Runners only one operator is needed per line. Four lines are in operation. This means that, at the prevailing labor rate of \$2.50 per hour per man, the I-R air tool provides a savings of \$160 daily.

10-SPINDLE MACHINE

This air-operated Ingersoll-Rand Multiple Nut Runner runs down ten bolts that fasten the intake manifold to the head of an automobile engine. The machine and its one operator replace two workers with single-spindle angle wrenches. Savings of \$160 per day result from the four units installed.

Application: Drilling Finished Holes

AN AIRCRAFT and missile manufacturer was faced with the problem of drilling thousands of holes of $\frac{3}{8}$ - to $\frac{5}{8}$ -inch diameter through many sheet and plate materials ranging to 2 inches in thickness. There were few long production runs and this ruled out expensive tooling. Further, due to the piece size, portable tools often had to be used. When the metal "sandwich" combinations were thin and made of soft materials, hand-held portable air drills were adequate. With the need for stronger and thicker airframe components, air-powered portable drills were needed. Otherwise operators couldn't drill accurate holes through the hard sections at a fast and efficient rate. Nevertheless these tools had shortcomings—they produced out-of-round and oversize holes due to long overhang of the drilling

unit; tools failed when they overfed in softer sections, or when they broke through the workpiece. Stalling occurred when drills were overloaded due to excessive feeding.

With all these problems, it was obvious that a new approach was required if production schedules were to be met. In the past the airframe builder had used Ingersoll-Rand air motors for many types of drilling and other portable tool uses. The concern decided to have a specialty tool manufacturer build a completely new close quarter mechanical feed drill powered by an Ingersoll-Rand Size 1 Air Motor. Several of the tools were designed and built, testing and evaluation followed. The new tool, with its mechanically controlled feeding rate, performs perfectly on drilling the many types of material combinations. It

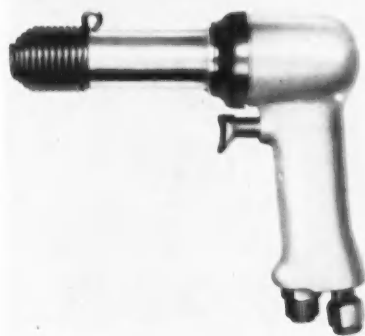
produces holes with a mirror-like finish; this finish is so satisfactory that on most production jobs, reaming is not required at all.

An example of the utility of the new units is shown in one case in which members close to the skin of an airplane had to be drilled with only $\frac{5}{8}$ -inch end clearance. One of the units with a 3-inch stroke transformed this tedious and slow drilling problem into a routine operation. Holes drilled in this instance were $\frac{1}{2}$ - and $\frac{5}{8}$ -inch in diameter.

Several savings result with the Ingersoll-Rand Air Motor-powered units. Cost of drilling is lower because overloading has been eliminated; time spent in reworking oversize and inaccurate holes has been vastly reduced; and a better hole finish eliminates the reaming operation.



Industrial Notes



NICKEL and chrome plating applied to H-52 Quik-Kouplers prevents rust under any conditions, and the use of Buna N washers provides the couplings with long, leakproof life, as explained in an 8-page brochure on the units. The couplings are designed specifically for pneumatic applications for working pressures to 125 psig. Some 45 different sizes are listed in the booklet for such applications as use on air tools, air motors, air cylinders and valves, automation machines, drill presses, riveters, and air clutches. Outlined in the publication is the manufacturer's H-52 vinyl plastic hose, designed to be used with the couplings. The hose is unharmed by oil, gasoline, corrosive atmospheres and most chemicals. It is lightweight, stands up under harsh use and has a smooth finish that assures steady flow. *Hofmann Engineering Company, 4022 W. Fifty-fifth Street, Chicago 32, Ill.*

TIME FOR FUN is a multicolored 8-page pamphlet issued by the National Safety Council as an off-the-job aid to help bring workers back from vacation safe and sound. It discusses driving safety, as well as good practices in swimming, boating, fishing and camping. The booklet stresses that even when a person is vacationing at home, he should take time for safety; this will leave time for fun. Single sample copies of the pamphlet and information on quantity prices may be obtained from the Council. *National Safety Council, 425 N. Michigan Avenue, Chicago 11, Ill.*

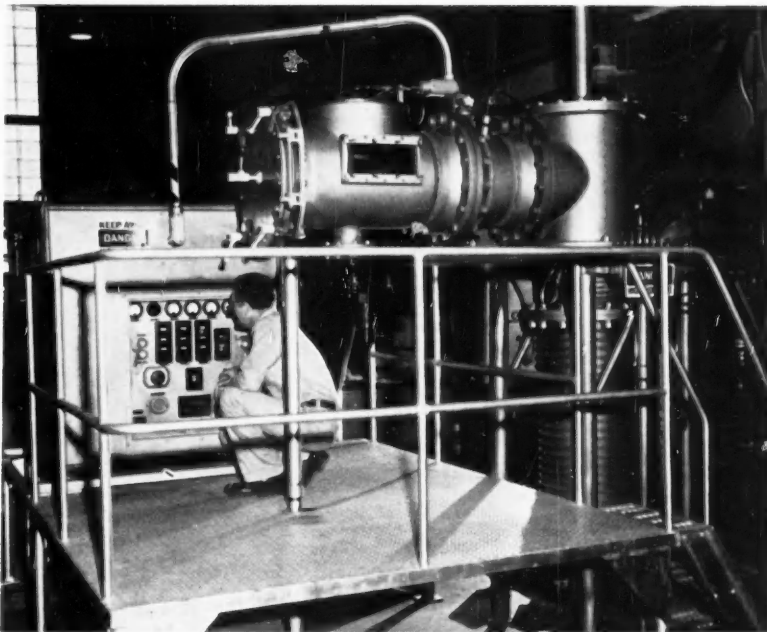
PURIFIERS, separators, mist extractors and scrubbers are discussed in Bulletin No. 803. It was published for engineers, operating executives and purchasing agents who need at their fingertips a complete catalog. The brochure provides solutions to a multitude of gas, air, steam and vapor entrainment problems by picturing and carefully describing the specifications and operations of practically every item in the Anderson purifier line. Thirteen Hi-eF purifiers are cataloged, including line types for entrainment removal service in large pipelines, receiver types designed for extremely large slugs of liquid, high-pres-

sure types capable of withstanding pressures to 15,000 psig, exhaust heads for cleaning exhaust gases and vapors discharged to atmosphere, internal types for evaporator and boiler service and small line types for keeping moisture and dirt from damaging pneumatic and steam tools. *The V. D. Anderson Company, division of International Basic Economy Corporation, 1935 W. Ninety-sixth Street, Cleveland 2, Ohio.*

TO MEET the close riveting tolerances of the jet age, Ingersoll-Rand has developed a new lightweight air-powered Shock Absorber Riveter. The tool is designed to cover a wide range of

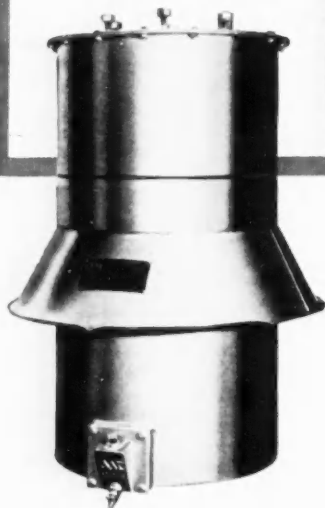
light riveting, chipping, scaling, calking and nailing tasks. It features a rubber-bonded shock absorber nozzle and has great power for its size. The nozzle reduces high-frequency vibration formerly transmitted from tool to operator and dampens the sound amplifying effect of the hollow barrel. Control is achieved by accurate throttling, simple built-in power adjustment and compact design. The straight-pull trigger and poppet-type, rubber-faced throttle valve provide smoothly graduated throttle control. A built-in power regulator reportedly permits adjustment to the proper

ELECTRON BEAM WELDER



An engineer is shown at the control panel of an electronic-beam welder that works in a vacuum to join high-melting-point metals extensively used in missiles and atomic reactors. The high vacuum prevents the exotic metals—beryllium, hafnium, molybdenum, tantalum and zirconium, to name a few—from being contaminated during the process. Welding is done inside the horizontal chamber located immediately above and to the right of the engineer. Built by Air Reduction Company's Central Research Laboratories, Murray Hill, N. J., the instrument's stream of electrons can be controlled down to a $1/16$ -inch diameter.

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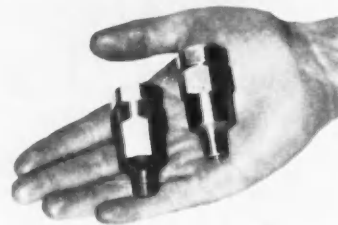
power and speed for each class of work. A sleeve-type valve, through which the piston passes, allows a long piston stroke in proportion to the barrel length. This results in a short over-all length with added power. The Shock Absorber Riveter comes in four power sizes with a choice of seven throttle handles, including offset design, pistol grip, and button throttle handles. Capacities range from $\frac{1}{8}$ - to $\frac{1}{4}$ -inch diameter to handle cold rivets of aluminum, and dural or soft iron. Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.

INDUSTRIAL and construction applications for a line of heavy-duty air motor jacks are explained in a 6-page brochure, Bulletin No. 435-IJ. Data are provided concerning all models in the line of Yello-Jackit units—20-, 35-, 50- and 100-ton capacities—in a performance chart accompanied by product photographs and cutaway drawings. The applications also have accompanying illustrations. Joyce-Cridland Company, 2027 E. First Street, Dayton 3, Ohio.

TO FILTER compressed air on small air-operated instruments, checking gauges, miniature valves and the like, thus preventing damage from sludge, rust and dust, filter Model 1117-2, illustrated here, will do the job. It measures $2\frac{1}{2} \times 1\frac{1}{8}$ inches and weighs only 4 ounces, making it possible to be attached directly to the import of an air device without causing inconvenience to the operator. The unit contains a filter cartridge that will check particles as fine as 5 microns in size. The cartridge is absorbent and will trap and hold oily sludge. It is reported that under average conditions, the cartridge life should be several months, despite its miniature



"Boss isn't such a bad guy now . . . but ten years ago he used to get in my hair."



size. Wilkerson Corporation, 1645 W. Girard Avenue, Englewood, Colo.

DESIGNED to ease the work of industrial rivet users, a guide called *Dimensional Standards for Semi-Tubular Rivets* contains standards data on all major classes of the semi-tubular fasteners. The 4-page chart includes such information as body and head diameters, head thicknesses and radii and hole diameter and depth figures. The guide was prepared by a special engineering committee of rivet manufacturers. Copies are available free of charge. Tubular & Split Rivet Council, 53 Park Place, New York 7, N. Y.

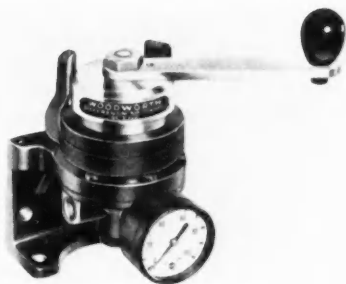
SMALLER and lighter in weight than its predecessor, Ingersoll-Rand's Size 804 Impactool has greater power and speed for use in production and maintenance



work in all industries requiring a $\frac{3}{8}$ -inch capacity nut runner. The unit is almost 2 inches shorter and $\frac{3}{8}$ pound lighter than its predecessor, and is designed to deliver 40 percent more power and 100 percent faster rundown. The Size 804 Impactool is said to be one of the most powerful tools for its rated capacity on the market today. Greater torque and speeds are made possible by a new direct-drive impact mechanism and improved Multi-Vane motor that assure peak efficiency without transmitting kick or twist to the operator. Having a steel hammer case for sturdy use, the tool has a precision-ground steel hammer-case bushing to maintain power and cut maintenance costs. A nylon-composition, self-lubricating trigger

gives long service life. The trigger is contoured to comfortably fit the operator's finger. The Size 804 weighs $5\frac{7}{8}$ pounds, is $6\frac{3}{8}$ inches long (measured to the shoulder of the square driver) and has a side-to-center distance of $1\frac{3}{8}$ inches. The tool runs with a free speed of 6000 rpm at 90-psig air pressure, delivering 1200 impacts per minute. The standard square driver measures $\frac{1}{2}$ inch across flats; an optional driver measuring $\frac{5}{8}$ inch across flats is available for severe applications. *Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.*

BUILT to be used with the manufacturer's diaphragm chucks and air-operated arbors, a differential air control is designed to increase or decrease clamping pressure during machining to control distortion. Two preselected pressures are used—one adjustable pressure to operate the air device, as for loading,



and the other to regulate the amount of air released when clamping the part. *N. A. Woodworth Company, 1300 E. Nine-Mile Road, Detroit 20, Mich.*

AN element for measuring mass rates of gas flow, independently of pressure and temperature, has been developed by National Instrument Laboratories, Inc. Basically, the element is an annular orifice, the area of which is controlled by a sealed bellows unit. The length of the bellows is a function of the temperature and pressure of the gas flowing through. The accompanying schematic drawing shows the operation of the meter. The location of the shaped plug in the orifice is determined by the pressure outside the bellows assembly. The annular space between the two concentric bellows forms a chamber in which a gas is sealed. The temperature of the gas within this chamber assumes the same temperature as the gas flowing in the line, thus the length of the bellows is determined by the temperature and the pressure of the flowing gas. As the pressure increases, the bellows shorten. The shaped plug extends farther into the orifice, reducing its area. (The plug shape is matched to the characteristics of the bellows so that the annular area

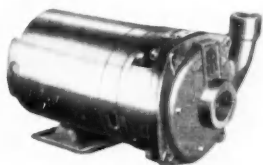
reputation for dependability



THERE'S A REASON why more and more Motorpumps are being specified today in all types of industry:

Only the Ingersoll-Rand Motorpump combines proven features with modern design engineering that provide rugged dependability, highest pumping efficiency. Motorpumps give you ease of installation, low cost operation and minimum maintenance.

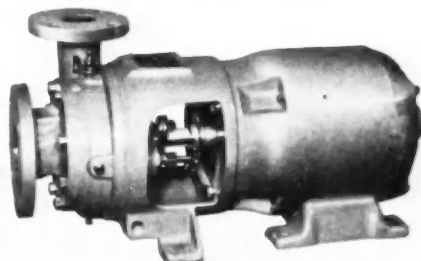
To meet your particular requirements, Motorpumps are available in the widest range of sizes and types. Capacities go from 5 to 2800 gallons per minute; heads to 650 feet. Write today for the latest bulletin.



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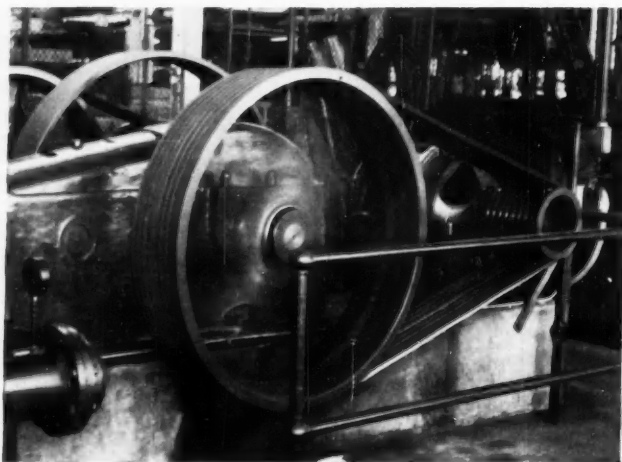
Ingersoll-Rand
MOTORPUMP

From $\frac{1}{4}$ hp to 75 hp



"POWER KING"

High Capacity V-BELTS



Greater Driving Power AT SUBSTANTIAL SAVINGS

Built with larger, stronger endless twin grommets to permit greater horsepower.

Fewer belts per drive, less over-all weight, smaller space required for any given load.

Greater flexibility—one-third more gripping power—very low stretch factor.

Switch to "Power-King" and note the savings they assure through increased load-pulling capacity and efficiency.

"If it's GOODALL, it MUST be Good"

Contact Our Nearest Branch

Standard of Quality—Since 1870

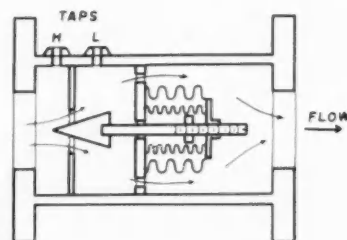


HOSE • BELTING • FOOTWEAR • CLOTHING
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GOODALL Rubber Company

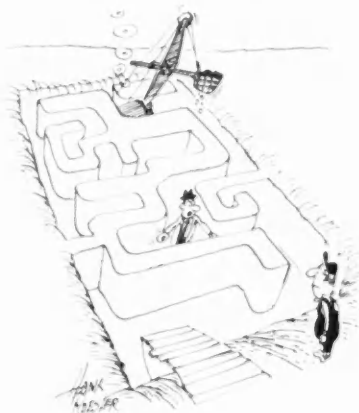
GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.
BRANCHES AND DISTRIBUTORS THROUGHOUT THE UNITED STATES.
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of the orifice is inversely proportional to the square root of the density of the gas. The square root of the differential



pressure produced across the orifice is then proportional to the mass rate of flow.) The gas sealed in the bellows is the same as the gas being measured. This is necessary to compensate for deviations from the perfect gas laws—the gas inside the bellows follows the same pressure-temperature density relationship as that flowing in the line. The meter is entirely of stainless steel construction, with the exception that low pressure units use phosphor bronze or brass bellows. *National Instrument Laboratories, Inc., 828 Evarts Street, N. E., Washington, D. C.*

CONTROL systems for completely automatic operation and protection of gas-engine compressors are described in a new flier (Form 3776) released by Ingersoll-Rand Company. The flier describes the company's Tendamatic control. It shows how it is applied to engine-compressors for gas transmission and distribution, oil and gas field services, refineries, chemical and industrial plants, and other compressor applications. Shown are Tendamatic control systems for Ingersoll-Rand electric-driven compressors on special services, as well as the Airpower Tendamatic control for 100-psig air compressors. A



"If I ever catch up with that shovel operator—he's through!"

NEW EJECTORS

Cut Vacuum Costs



New Series M Steam Jet Ejectors, with rugged, two-piece construction, offer big savings for general vacuum service

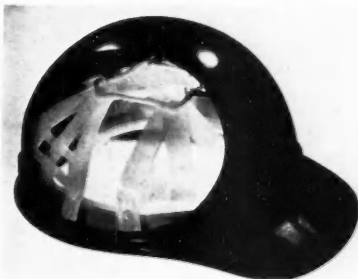
FOR CREATING vacuums, there is nothing simpler or more reliable than the new Ingersoll-Rand Series M ejectors. Designed to operate with 75 to 200 psig steam, they can handle either dry or wet gases and can be used for priming pumps and other hydraulic equipment. The low-cost Series M line includes 1½", 2" and 3" sizes with threaded connections and 4" size with flanged suction and discharge. For full details, send for new Bulletin No. 9046.



Ingersoll-Rand
4917 11 Broadway, New York 4, N. Y.

typical Tendamatic-controlled engine-compressor installation is described, listing the functions that can be performed. These include automatically timed steps for starting procedure; speed and capacity regulation; constant guarding of unit against any malfunction; normal shutdown control; and sequence control. Tendamatic control watches for any abnormal condition and warns the operator if one occurs. In case any condition reaches a danger point, Tendamatic sounds a horn, flashes a red light that identifies the trouble, and stops the unit. *Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.*

SAFETY hats and caps of fiber glass, aluminum and plastic for all industrial, mill and mining applications feature a polyethylene suspension that reportedly provides a high measure of safety. The suspension includes lock-straps at the peak that assure 1¼-inch clearance between the crown and hat shell. A plastic-zippered leather or leatherette sweatband may be replaced in a few seconds without the need of replacing or dis-



turbing any part of the suspension. The headgear, available in sizes from 6½ to 8, are fully resistant to water or moisture absorption or corrosion and all exceed Federal standards for hard-hat safety. The fiber glass hat is available in a variety of colors, including white, green, blue, brown, red, orange, yellow and gray. There also is a phosphorescent finish for applications in which a hat that glows in the dark is desirable. *Boyer-Campbell, Safety Division, 6540 St. Antoine Street, Detroit 2, Mich.*

Films . . .

Motors in the Making is a 31-minute, 16-mm sound and color film that shows, step-by-step, the processes in the manufacture of electric motors, including frame fabrication, stator winding, rotor casting and winding, assembly, testing, and packaging for shipment. A series of scenes describes the testing of materials, tools and instruments used in the manufacturing operations. Its narration is clear and factual, but not highly technical. The motion picture may

ADAMS

FACT FILE #2

PLANT AIR

Moisture Chief Cause of Trouble . . .

Every company today is looking for ways to offset the increased costs of labor, material, equipment and services. At a gasoline station you expect "Free Air", but in industry it is a major expense. Perhaps in your own plant, for an investment in a few minor compressed air system alterations, significant savings are possible.

Water, sludge, rust, oil and dirt in compressed air systems are prime causes of maintenance and production down-time. Water vapor condensing in air lines tends to corrode the piping. Also, water present in the piping may freeze during winter, causing serious reduction of compressed air supply. Such restrictions are often difficult to locate and thaw. This same line moisture may emulsify lube oil destroying its lubricating value and the resultant mixture has high fouling characteristics. Frequently, ice will form within the tool itself since expanding air cools the moisture . . . tool efficiency will be seriously affected.

Some of the Other Problems Created By Wet Compressed Air . . .

Wet compressed air is not only a construction and production tool problem. Faulty paint jobs, contaminated chemical and food products can often be traced to moisture laden compressed air. Water-hammer, unequal pipeline thermal expansion and line leaks also result from collected moisture. In addition, air lost through traps, and in blow-down of compressed air lines provide no useful work . . . represent a sizeable power loss.

You Can Lick Compressed Air Moisture Problem . . .

All of these hidden costs can be virtually eliminated by the installation of an Adams Aftercooler and Cyclone Separator between the compressor and receiver tank. By cooling discharge air to within 10° F. of cooling water temperature — guaranteed with Adams standard Aftercoolers — the moisture can be removed at the separator. Pressure loss is less than one-half pound on these units including the separator. In severe cases, moisture removal of over 90 per cent can be obtained by cooling the air with Adams 2° Aftercooler to within 2° F. of water temperature.

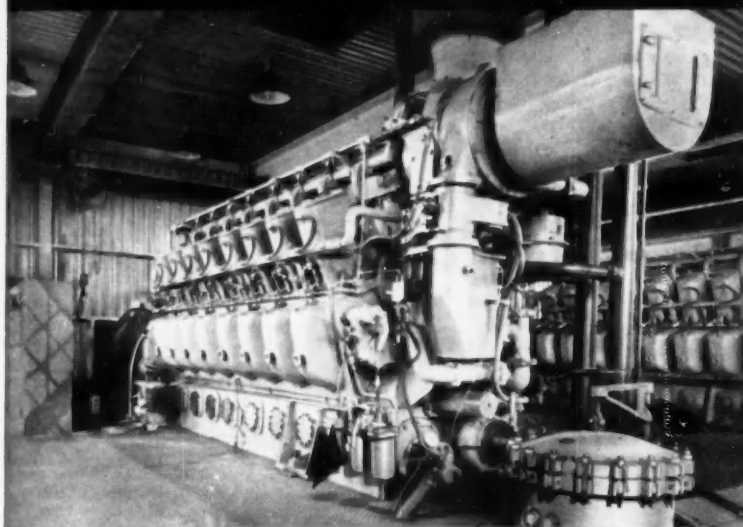
Air Filter for Final Protection at Point of Use . . .

As an added safeguard for expensive tools and equipment, an Adams Poro-Stone Air Filter should be installed just before the air is used. These filters remove all solid material picked up by the air stream. With an Adams Aftercooler, Cyclone Separator and Air Filters clean, dry, trouble-free air is supplied to your production tools. You get continuous service with minimum maintenance.

For further information on how the complete line of Adams air equipment can solve your compressed air problems, write today for your free copy of Bulletin No. 712 on Aftercoolers and Bulletin No. 117 on Poro-Stone Air Filters from the R. P. Adams Company, Inc., 100 East Park Drive, Buffalo 17, New York.

THESE ENGINES EQUIPPED WITH NUGENT FILTERS

.....
have operated over 18 months
without changing lube oil
or filter cartridges



"These Alco 251 Diesels, equipped with Nugent Full-Flow Filters, have operated over 18 months without changing lube oil or filter cartridges."

This report from the Laton (Kansas) Pumping Station of Service Pipe Line Company is further positive proof of the dependability and economy of Nugent Filters.

The filters employed at Laton are Nugent's Fig. 1555 Laminated Fiber Disc Type. They filter all the lube oil in circulation every cycle before it goes to the bearings. Foreign particles as small as 2 or 3 microns are removed . . . oil is kept cleaner . . . oil life is actually extended.

The service life of your valuable equipment can be materially lengthened by providing the best filtering protection available. This is the business of the Nugent Co. Write for descriptive literature, today.



Nugent Fig. 1555 Filter Cartridges remove microscopic foreign solids.



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OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

be borrowed without charge by industrial, commercial, engineering and educational groups through Wagner Sales Branches. Further information may be obtained by writing to Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis 14, Mo.

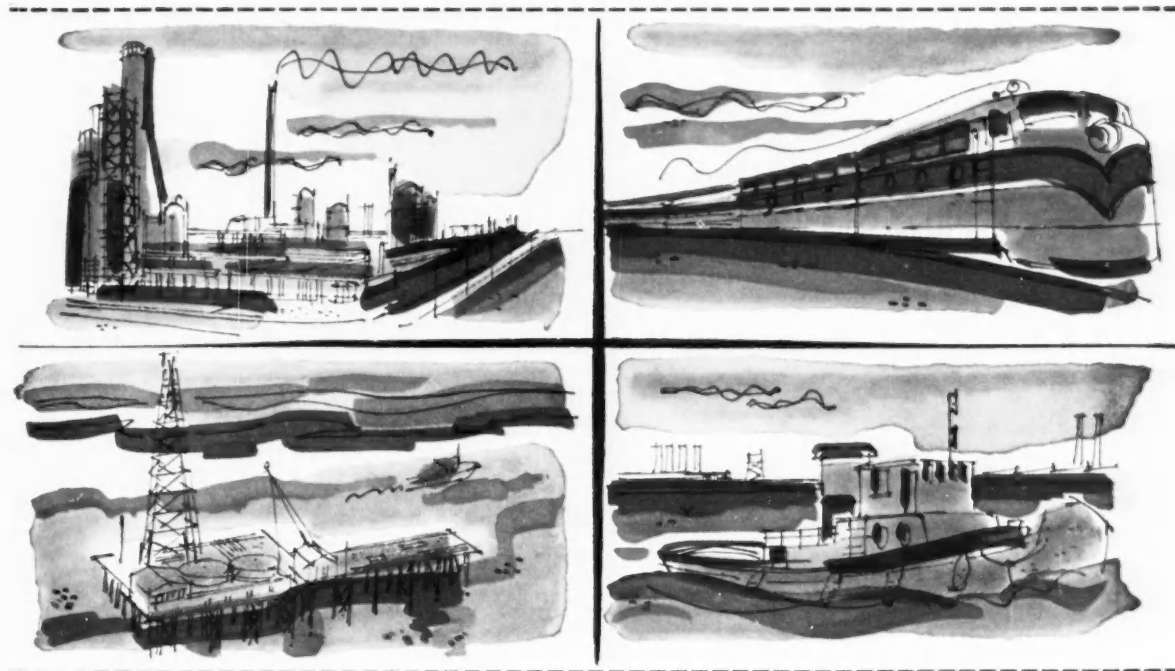
Books . . .

Steam Power Plants: Starting, Testing and Operation (published by McGraw-Hill, 327 W. Forty-first Street, New York 36, N. Y.) was written by Charles Donald Swift, a mechanical engineer in the Consulting Department of Ebasco Service, Inc. It is a broad-scoped, 1-volume guide to steam power plants, including their physical set up, various components, and techniques for efficient operation. The book follows a steam plant from the design and construction stages through those preparatory to starting; and discusses the organizing of personnel and facilities, the starting of a new plant, the development of operating procedures, and the arranging of test routines needed to keep the plant operating at top economy. The essential components described include turbines, boilers, auxiliaries, electrical apparatus and water-treating equipment. Techniques that must be understood to follow the steps for organizing the plant are also included. All classes of steam boilers and steam electric plants, from pressures above low-pressure heating installations to supercritical high-temperature installations, are described. The illustrated book explains the mode of operation of the various kinds of power plant apparatus and how they are linked into a complete operating power plant. It also points out factors that will help avoid trouble while at the same time boost economical power production. 416 pages. Cost, \$11.50.

SHOES



"I want something in a mahogany finish that will match my desk top."



it's KOPPERS Piston Rings

Where profit depends on keeping equipment in service, engineers recognize the importance of ring performance. That is why Koppers Piston Rings go into the finest engines in the world . . . why they are selected for replacement when better performance is demanded.

Since the first diesel engine, Koppers has produced piston rings of predictable performance in a complete range of materials and a wide selection of types and sizes. If you have a ring problem, Koppers can offer you the benefit of their experience. Write to: KOPPERS COMPANY, INC., Piston and Sealing Ring Department, 4108 Hamburg Street, Baltimore 3, Maryland.

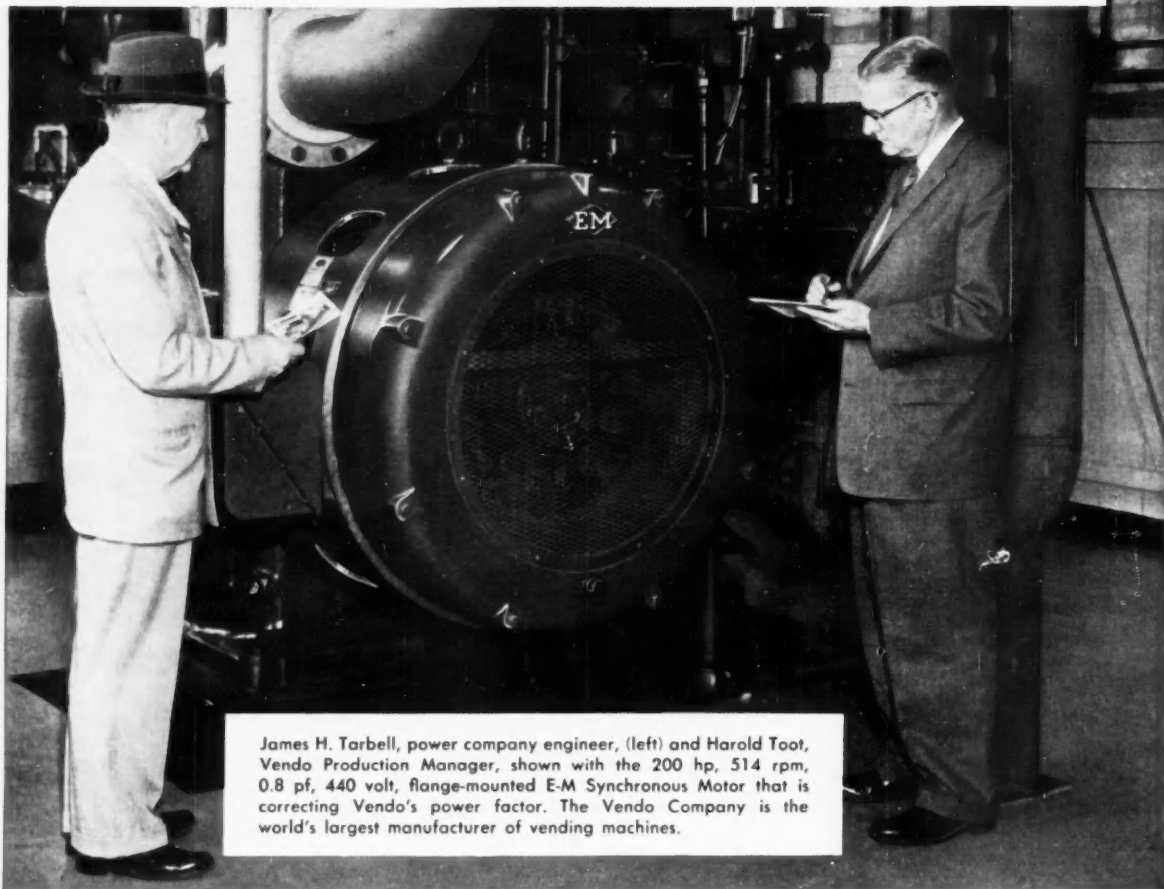
Send now for Koppers recommended Piston Ring Set-Ups applicable to the engines which you operate.



PISTON AND SEALING RINGS

Engineered Products Sold with Service

Are You Paying Big Penalties for Lagging Power Factor?



James H. Tarbell, power company engineer, (left) and Harold Toot, Vendo Production Manager, shown with the 200 hp, 514 rpm, 0.8 pf, 440 volt, flange-mounted E-M Synchronous Motor that is correcting Vendo's power factor. The Vendo Company is the world's largest manufacturer of vending machines.

Vendo Company Corrects Power Factor... SAVES \$450 A YEAR! with an E-M Synchronous Motor

The Vendo Company, Kansas City, Missouri learned its plant was operating at a lagging power factor condition when expanded production facilities required more compressed air. A study by Vendo's engineers and Kansas City Power & Light Company showed an 0.8 leading power factor synchronous motor compressor drive would save them money. Here's how:

Vendo's power contract provides a penalty of 20 cents a month for every reactive kva exceeding one-half the maximum kilowatt demand. *This was costing Vendo \$33.00 per month, or \$396.00 a year!*

A 20 cents a month bonus is granted for every kilovar the reactive demand falls short of one-half the maximum kilowatt consumption. A 200 hp E-M Synchronous Motor with 0.8 pf would provide enough reactive kva for Vendo to operate at a leading power factor and earn a monthly credit of \$4.60. Vendo's power bill would then be reduced by \$37.60 a month, or \$451.20 a year!

Vendo installed the recommended E-M Synchronous Motor... and has been enjoying a reduced power bill ever since. You, too, can make a big saving in your plant power bill by correcting your power factor with highly efficient E-M Synchronous Motors.

Learn more about Power Factor. Call your nearby E-M Sales Engineer and write for your free copy of the new E-M 24-page brochure, *The ABC of Power Factor*.

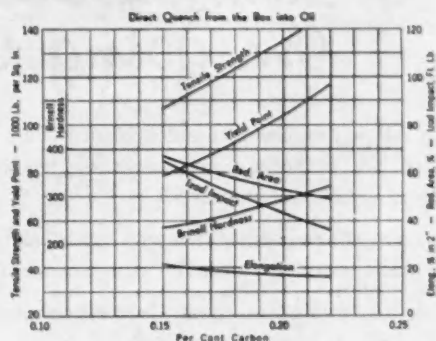


ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

TOUGH 4620

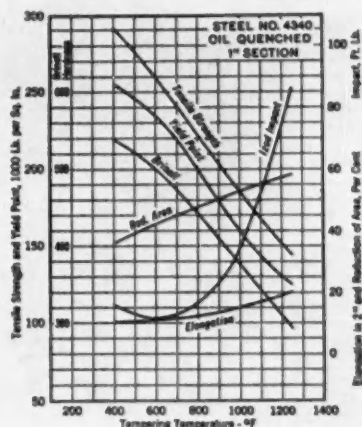
4620 VALVE CHEST PLATE
4620 VALVE CHEST
4620 VALVE
4620 VALVE SEAT
4620 VALVE GUIDE



Average core properties of 1 inch bars, pseudo-carburized at 1650-1700° F. and heat treated as indicated. All bars tempered at 300° F. after treatment.

STRONG 4340

4340 CHUCK



2 nickel steels help Ingersoll-Rand give its Downhole drill "all-rock" versatility

These wrought nickel alloy steels, heat treated for maximum properties, account, in part, for the high performance of this drill. You can see above where these steels are used.


These charts summarize the properties that lead to their choice. Below are described the areas in which these nickel-containing steels prove particularly useful. Bear in mind that both are exceedingly tough and resistant to impact — thanks to Nickel.

A.I.S.I. 4620; C .20, Ni 1.80, Mo .25. This steel develops a hard case for good wear resistance with a bonus in core toughness (see chart) and impact resistance. Its reliability and minimum distortion in heat treatment give an added plus in processing of parts having critical tolerances.

A.I.S.I. 4340; C .40, Ni 1.80, Cr .80, Mo .25. Notice that 4340 steel is used for the chuck, a critical part requiring a combination of high impact and wear but where strength is para-

mount. Oil quenched and tempered, 4340 is just the steel for this use.

Make yourself acquainted with the ways nickel alloy steels can improve the performance of your equipment. These 2 steels are readily available from your Steel Service Center. Where metal difficulties develop with a special part, call on Inco Nickel for possible solutions.

The **INTERNATIONAL NICKEL COMPANY, Inc.**
67 Wall Street  New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

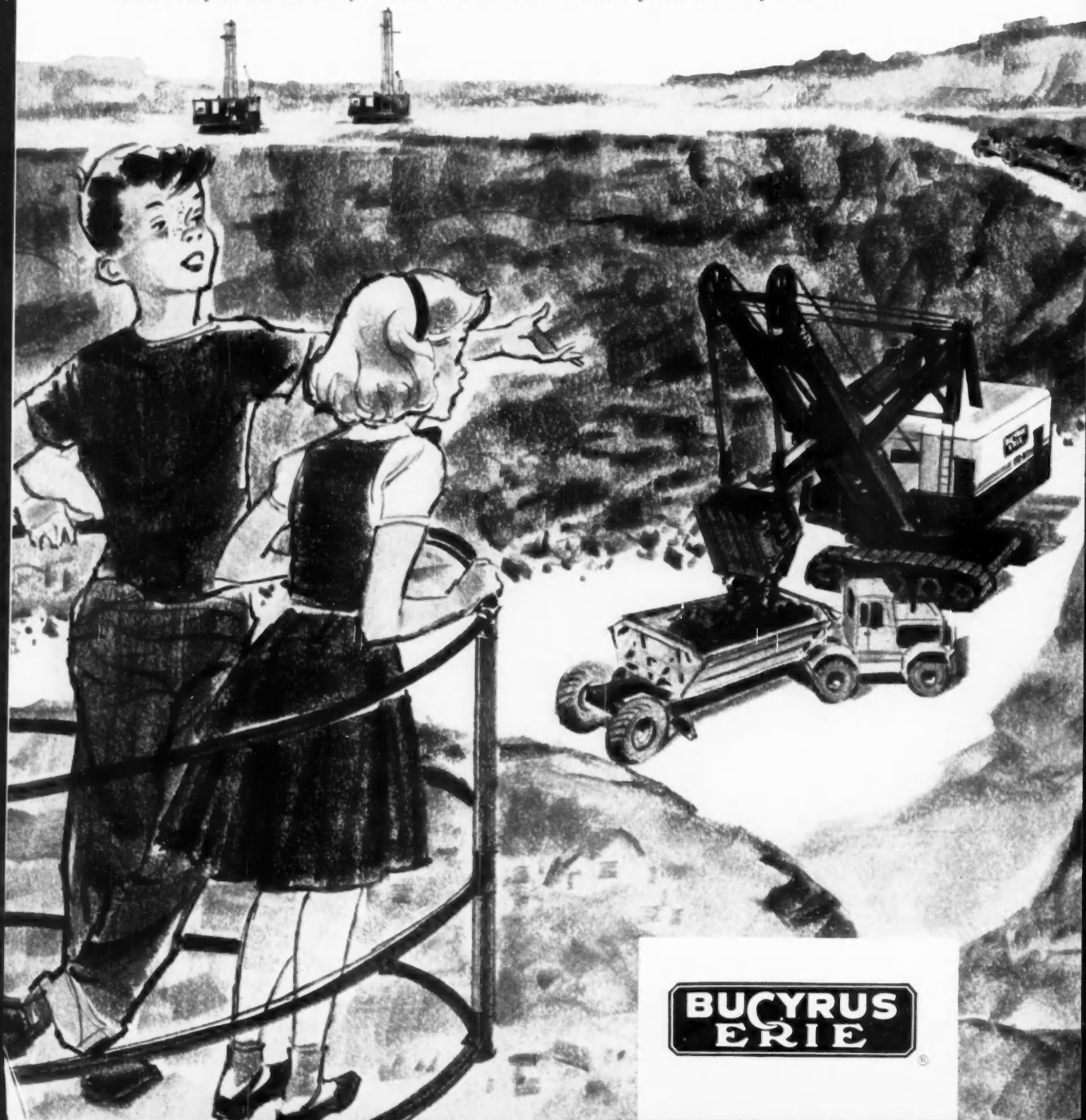
"when I grow up I'm going to run one of those"

When a fellow daydreams out loud to his best girl, he dreams *big*. Running a big Bucyrus-Erie electric shovel means he's really arrived!

Many a mine or quarry owner who's now "arrived" got his start years ago with Bucyrus-Erie electrics.

That's why two out of every three shovels on the

great iron ranges of northern Minnesota and upper Michigan are Bucyrus-Eries. It's also why B-E machines have long been *the standard* in large quarries, in open pit mines, and on the biggest dam and construction projects all over the world. *Wherever important jobs require the best equipment* — that's where you'll see Bucyrus-Erie.



**BUCYRUS
ERIE**

Here is the pair
for clean, dry
air . .

JOHNSON AFTERCOOLER

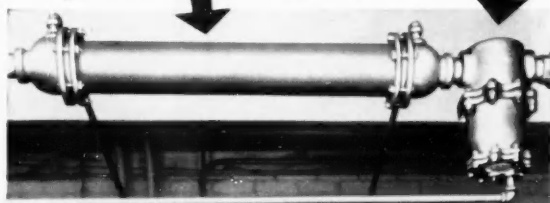
Used where moisture is vaporized by the heat of compression. Circulates cooling water around the line, condenses the oil and water vapor so Separator can remove them. Simple in design, highly efficient in performance.

SIZES
FOR ALL
NEEDS

JOHNSON SEPARATOR

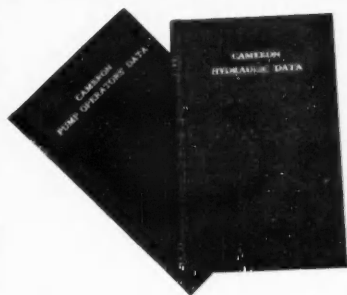
Removes more than 99% of all water, dirt and oil from compressed air or steam. Combines the two best principles of separation—first allows air to expand slightly, then changes flow direction with the "Thousand Baffles", the newest idea in separator design, with self-draining trap mechanism built right in.

WRITE FOR
BULLETIN



The Johnson Corporation

830 Wood Street • Three Rivers, Mich.



TWO HANDY REFERENCE BOOKS

for

The Engineer, The Superintendent, The Operating Man

CAMERON PUMP OPERATORS' DATA:

Contains practical information covering the installation, operation and maintenance of centrifugal pumps.

CAMERON HYDRAULIC DATA:

Covers data useful in work involving the handling of liquids, steam, and water vapors.

Cameron Pump Operator's Data \$2.00

Cameron Hydraulic Data \$3.00

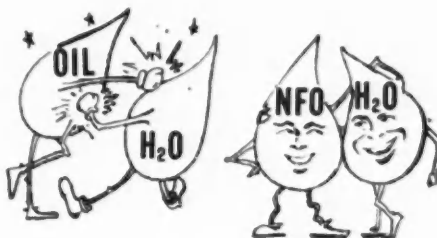
For Sale By:

COMPRESSED AIR MAGAZINE

942 Memorial Parkway

Phillipsburg, N. J.

ABSORBS MOISTURE



NON-FLUID OIL

TRADE MARK REGISTERED

Don't tolerate worn, rusted pneumatic tools! Since you can't "lick" the ever present moisture in compressed air, why not join it? The new "NR" Grades of NON-FLUID OIL absorb this moisture into the Lubricant, forming a stable emulsion. "NR" Grades of NON-FLUID OIL provide these extras:

- Perfect lubrication.
- Complete protection against rusting.
- No gumming or sticking.
- Tool speeds increased from 10% to 30%.
- Winter grade available with pour point of -30°F.

NON-FLUID OIL is approved by all leading manufacturers of air tools and used by the majority for initial run-in after assembly. You will see why if you write for a free testing sample and Bulletin 550.

NEW YORK & NEW JERSEY LUBRICANT COMPANY

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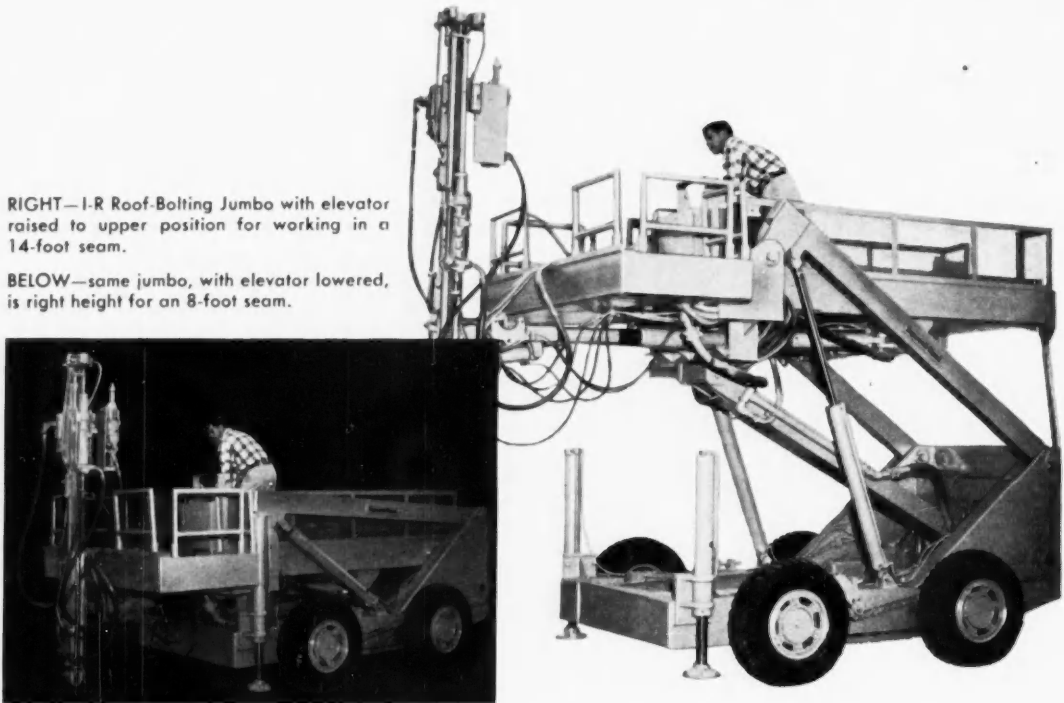
Also represented in principal industrial centers, including Pittsburgh, Pa., Cleveland and Cincinnati, Ohio.

NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture. So-called grease imitations of NON-FLUID OIL often prove dangerous and costly to use.

MECHANIZED ROOF-BOLTING

RIGHT—I-R Roof-Bolting Jumbo with elevator raised to upper position for working in a 14-foot seam.

BELOW—same jumbo, with elevator lowered, is right height for an 8-foot seam.



Special I-R ROOF BOLTING JUMBO drills, drives, and tightens bolts in 8 to 14-ft seams

Ingersoll-Rand rock drill engineers have come up with a unique solution to a troublesome roof-bolting problem on a job where with conventional stopers and temporary stagings, roof-bolting crews were hard pressed to keep ahead of drilling operations in a room-and-pillar mining system. Drillers often had to wait for roof bolts to be set before they could move in on a new face. Now a two-man crew easily keeps ahead of all drilling operations.

Each self-propelled jumbo consists of an elevator platform which carries a Hydra-Boom-mounted vertical drill feed with DB-30 drifter and Torque Control Impactool.

In operation, the jumbo is propelled into

approximate drilling position by I-R air-motor drives—anchored with hydraulic leveling jacks—and the platform raised by hydraulic cylinders to the desired height. The drill is spotted in position by the Hydra-Boom and the hole is drilled. The drifter is then run down the feed, the steel removed and the Impactool swung into position above the drill. The roof bolt is inserted and drill feed raises the wrench into position for tightening the bolt to the required torque. All operations are throttle controlled from the upper deck.

If you have a drilling problem, Ingersoll-Rand's specialized experience can help you solve it—quickly and efficiently.



Ingersoll-Rand

S 934

11 Broadway, New York 4, N.Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR ROCK DRILLING



Drill Steel helps move 900,000 cu yd for new mountain highway

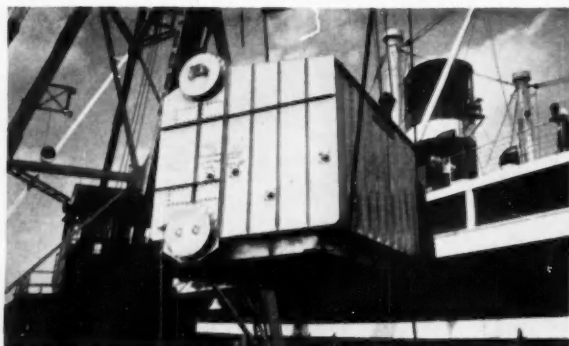
These wagon drills, using Bethlehem Hollow Drill Steel, were photographed recently as they bored blast holes in hard sandstone atop Broad Mountain, in eastern Pennsylvania. The 2½-mile project, on winding Route 29 near Nesquehoning, was handled for the Pennsylvania Dept. of Highways by J. H. Beers; Howells Mining Drill Corp. serviced the drill steel. The Bethlehem Hollow, which comes in Carbon and Ultra-Alloy grades, turned in a low-cost job . . . just as it is doing in hundreds of rock removal projects across the nation.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

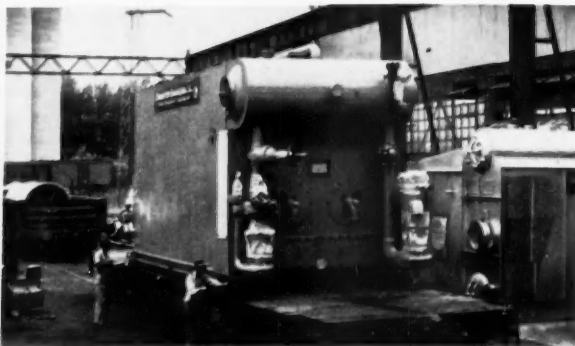
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL





▲ A C-E Package Boiler, Type VP, en route to Europe. This boiler type is available with capacities from 4,000 to 90,000 lb of steam per hr, with pressures to 700 psi and temperatures to 750 F in certain sizes. It is designed for oil or gas firing. Several hundred of these units are now in service.



▲ A shop-assembled Controlled Circulation Boiler, Type PCC, being prepared for shipment. This type unit is available with steam capacities from 80,000 to 120,000 lb per hr, and with pressures and temperatures to 1000 psi and 900 F. For special applications, designs are available to provide higher steam pressures and temperatures. Seven PCC Boilers are now in service.



▲ A shop-assembled C-E High-Temperature Water Boiler, Type HCC, being unloaded at a midwest manufacturing plant. It is one of two 12-million-Btu boilers used for plant heating. Available for capacities from 10 million to 300 million Btu, this unit type is shop-assembled in sizes up to 50 million Btu for oil or gas firing—up to 40 million Btu for coal firing. Currently, more than 50 HCC Boilers are in service or on order.

NOW

C-E offers LARGER SHOP-ASSEMBLED BOILERS

Three service-proved designs with capacities to 120,000 lb per hr... pressures to 1000 psi... temperatures to 900 F

The economies inherent in shop-assembled boilers can now be yours even if your steam requirements are as high as 120,000 lb per hr. The C-E line, consisting of three basic unit types, has been expanded to include pressures, temperatures and capacities well beyond normal package-type limits.

The standard, natural-circulation, **C-E Package Boiler—Type VP**—is now available with capacities to 90,000 lb per hr, and with pressures and temperatures to 700 psi and 750 F.

Where greater steaming capacity is required, or where higher pressures or temperatures are needed for industrial processing or power generation, the shop-assembled **C-E Controlled Circulation Boiler—Type PCC**—is available. It is designed for the 80,000-to-120,000-lb capacity range, with pressures to 1000 psi and temperatures to 900 F. For special applications, this unit is also available for considerably higher pressures and temperatures.

The **C-E High-Temperature Water Boiler—Type HCC**—is an ideal type for large space-heating and certain

process uses. It is also available in shop-assembled form for capacities to 50 million Btu per hr. It is designed for pressures to about 500 psi, and can provide water at 450 F or higher.

The new, high-capacity ranges of these shop-assembled units represent the logical evolution of familiar and successful designs that have been proved in service for quality, economy and performance.

Catalogs on any or all of these units available on request.

COMBUSTION ENGINEERING



C-202B

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.
Canada: Combustion Engineering-Superheater Ltd.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

TOOL-OM-ETER The Pulsation Compensated AIR METER

4 Ranges Covering From
4 to 450 CFM



- SIMPLE AND PRACTICAL OPERATION
- RELIABLE AND DURABLE
- PORTABLE FOR FIELD TESTING
- ACCURACY BETTER THAN 99%

New Jersey Air Meters are accepted everywhere as the most practical, reliable and accurate method of air measurement. With the aid of these meters, you can intelligently select the most suitable equipment for your service, maintain this equipment in effective operating condition, make repairs and adjustments when needed, locate leaks and losses, and scrap the "air eaters" when they become obsolete or worn beyond repair.

These meters show directly on a scale, in cubic feet of free air per minute, the flow of air in a pipe or hose. They measure the air consumption of any pneumatic tool, rock drill, air motor, sand blast, air lift, or other application of compressed air. They permit the control of air flow to any operation or process at the rate that gives the most effective production and highest air economy.

FOR THE COMPLETE STORY, WRITE FOR BULLETIN A-8

NEW JERSEY METER CO., INC.

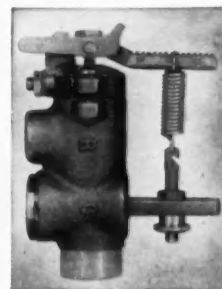
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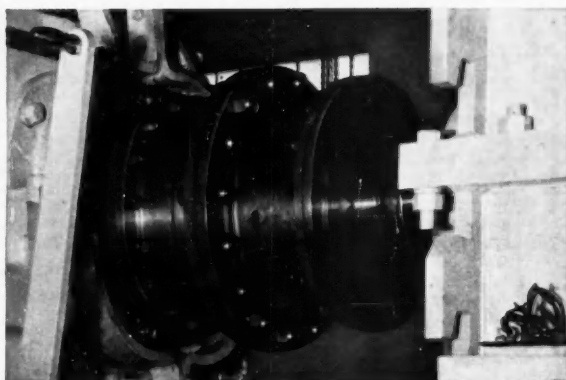
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AT WALDRON... Specials ARE STANDARD AND VICE-VERSA



In the picture above is a Waldron #8 Cut-Out Coupling. It couples the power to a shearing machine, which takes mild steel strip from coil, straightens it and cuts it to lengths between 3' and 24' at the rate of 1250 feet per minute.

This is a Waldron "special" because it was developed for a particular application. Waldron engineers put a lot of know-how into producing this unit, but with their knowledge acquired through years of experience in dealing with many similar power transmission problems, it became a simple task.

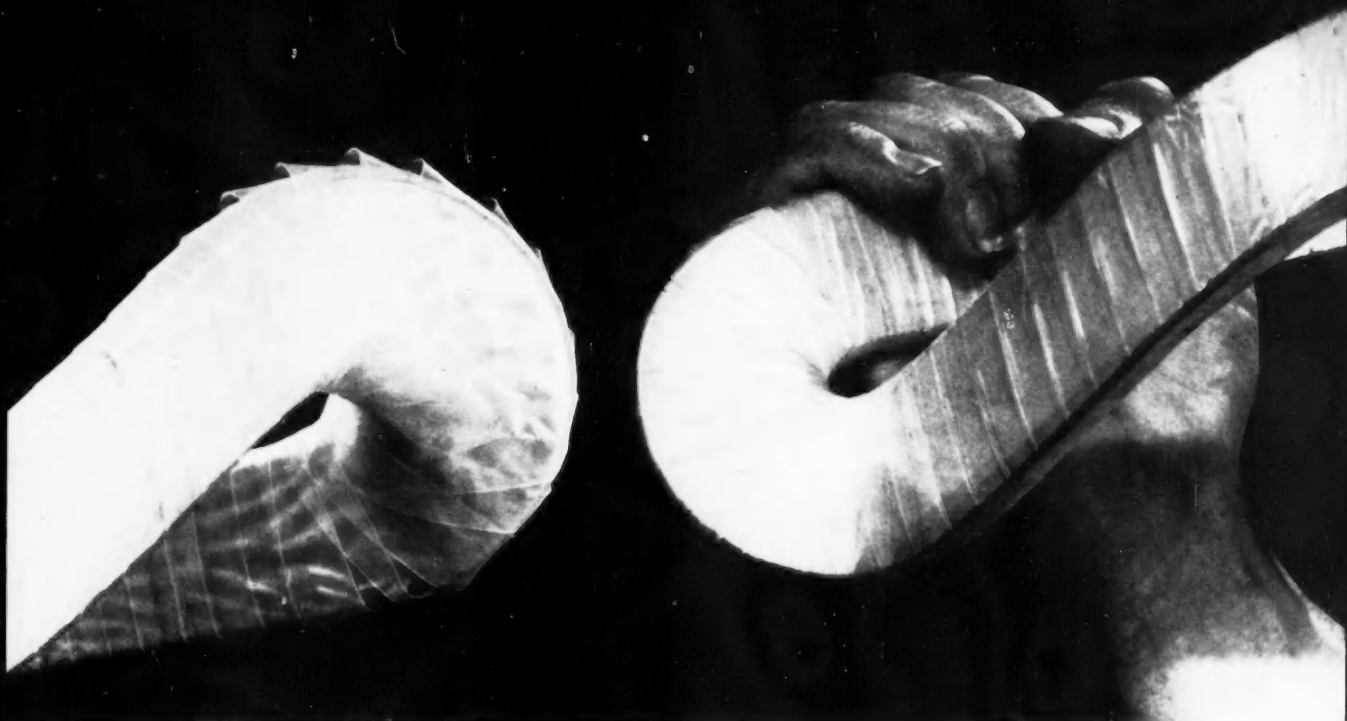
On the other hand, "standard" couplings receive so much attention in production, that they run as if specially designed for the application. Waldron believes that the coupling is as important as the driver and the driven and so should receive the same fine forgings, machining and assembly as the equipment it couples.

If you are in the market for couplings, either specials or standards, speak to the engineers at Waldron. In both cases you will be assured of the highest quality possible.



JOHN **WALDRON** CORPORATION

Subsidiary of Midland-Ross Corporation
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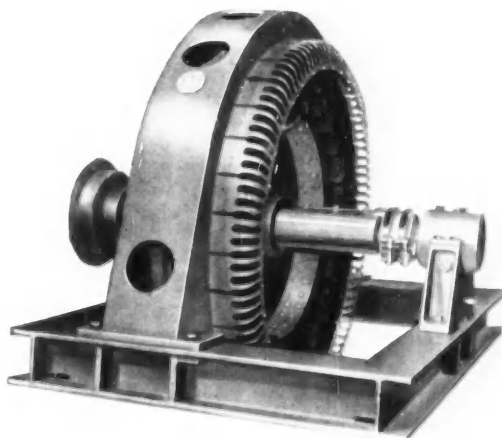
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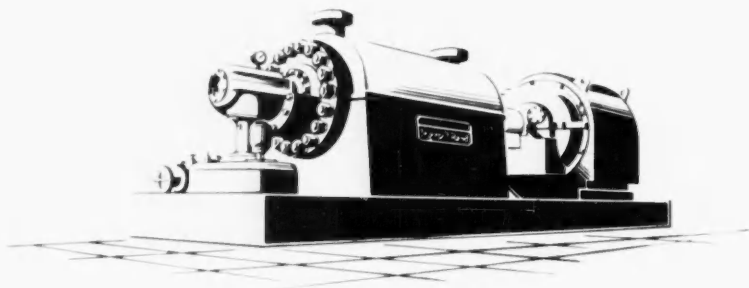
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